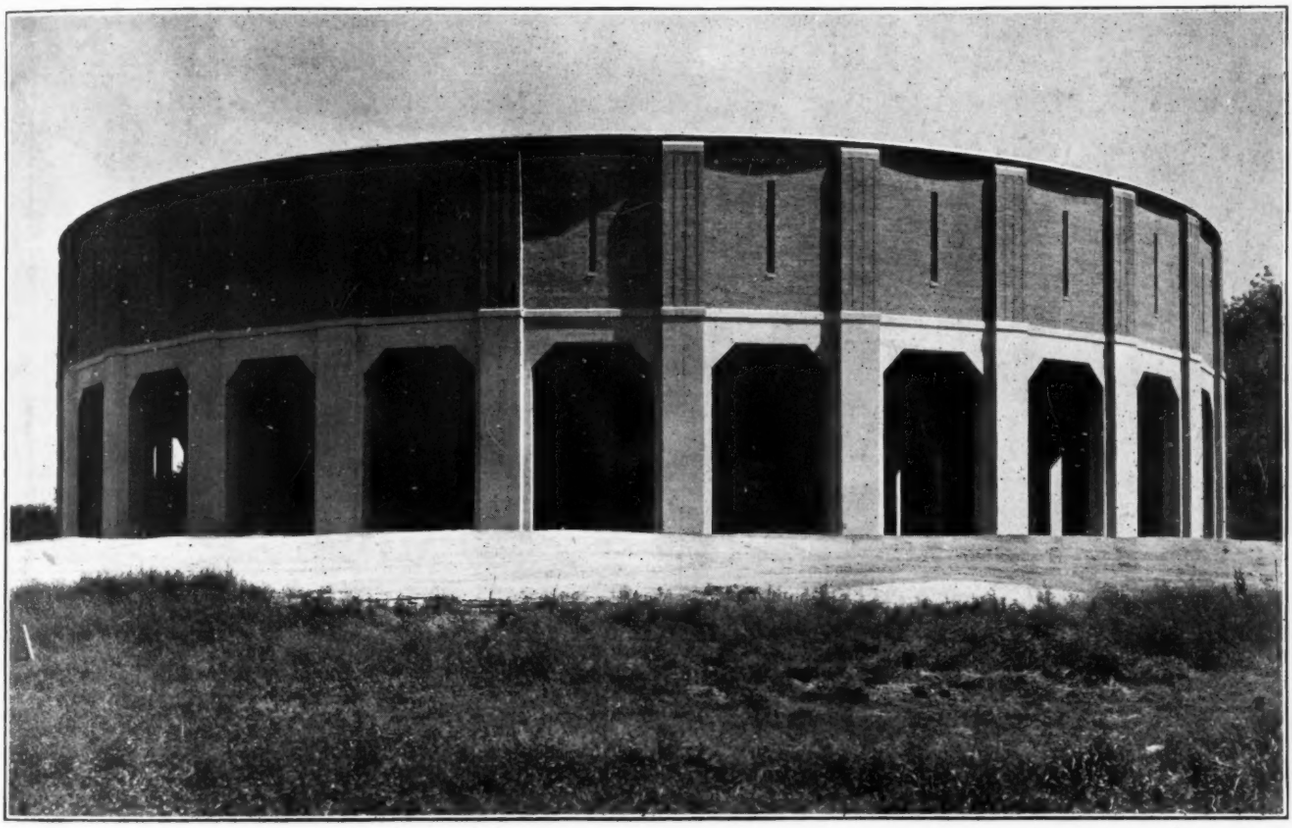
WATER WORKS AND SEWERAGE

September, 1933 — Editor — Vol. LXXX. No. 9



The 4,000,000 Gallon Elevated Storage Reservoir of Sheboygan, Wis.

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Sewage Disposal at Spartanburg, S. C.

A 4,000,000 Gallon Elevated Storage Project

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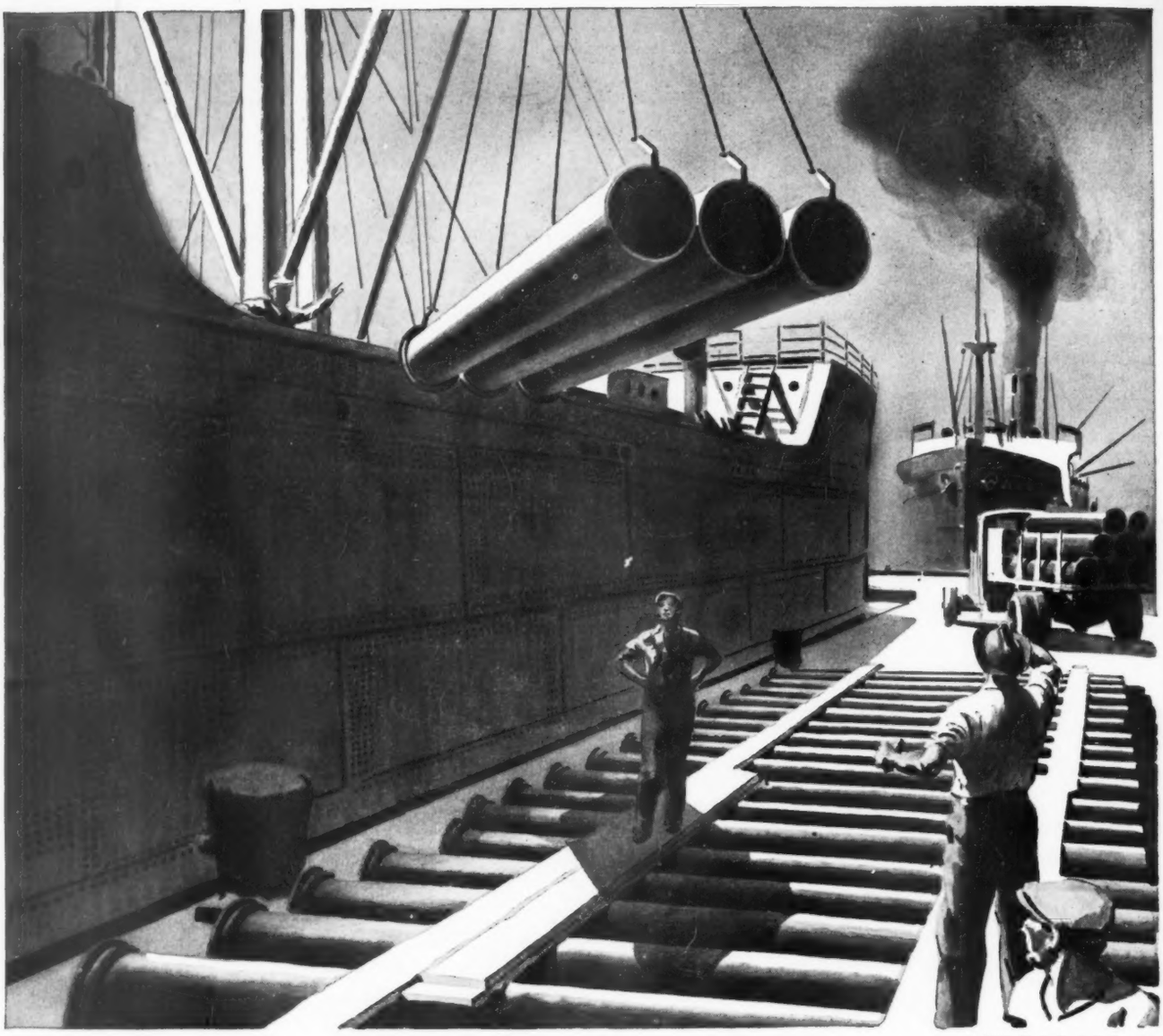
Notes on Ferric Chloride Coagulation of Sewage

Grit and Screening Incineration Plant at Milwaukee, Wis.

Obstacles Encountered in Estimating Flow Through Filters



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L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

R. W. Haywood, Jr., Superintendent of Filtration, Lehigh Water Company, has submitted an article describing the new filtration plant at Easton, Pa., which was scheduled for this issue. It will appear in the October issue.

Darwin W. Townsend, Principal Assistant Engineer of the Sewerage Commission of Milwaukee, whose article describing the new grit and screenings incineration plant at Milwaukee appears in this issue, will contribute a follow-up article. Experiences in operation and operating cost data will be revealed in his second article.

J. S. Dunwoody, Superintendent of Water Department, Erie, Pa., tells of the methods followed at Erie in "Handling of Storage Yard Supplies and Equipment" in an article illustrated by specimen record forms and photographs.

Alexander Potter, Consulting Engineer, New York City, discusses "Chemical Precipitation in Sewage Treatment" from the standpoint of its practicability, economy and dependability, based on first hand experiences of the author.

Paul W. Frisk, Chemical Engineer, American Enka Corporation, Enka, N. C., will write on their experiences with iron and manganese in filtration practice and the methods evolved in maintaining cleanliness of the filters serving a large textile mill.

Walter A. Sperry, Superintendent of Sewage Treatment Works, Aurora, Ill., will describe a study of flow-through characteristics of sewage settling tanks and means evolved to create higher efficiencies including the installation of effective baffling devices.

George H. Prindle, Superintendent of Water Works, Highland Park, Ill., writes on the important topic, "Using Perspective in Expenditures for Water Purification."

H. H. Hendon, Sanitary Engineer of Jefferson County, Birmingham, Ala., will describe the Shades Valley project in which 3.5 miles of 42 inch special cast iron with light weight bells was employed.

Sheppard T. Powell, Consulting Chemical Engineer, Baltimore, Md., will relate experiences with "The Corrosion of Well Casings by Electrolysis."

Frank C. Roe, Engineer of the Carborundum Company, Niagara Falls, N. Y., will describe the most satisfactory methods employed in cleaning and servicing air diffuser plates and tubes at sewage treatment plants.

V. J. Hultquist, City Manager of Alcoa, Tenn., writes an illustrated article on "Plant Beautification."

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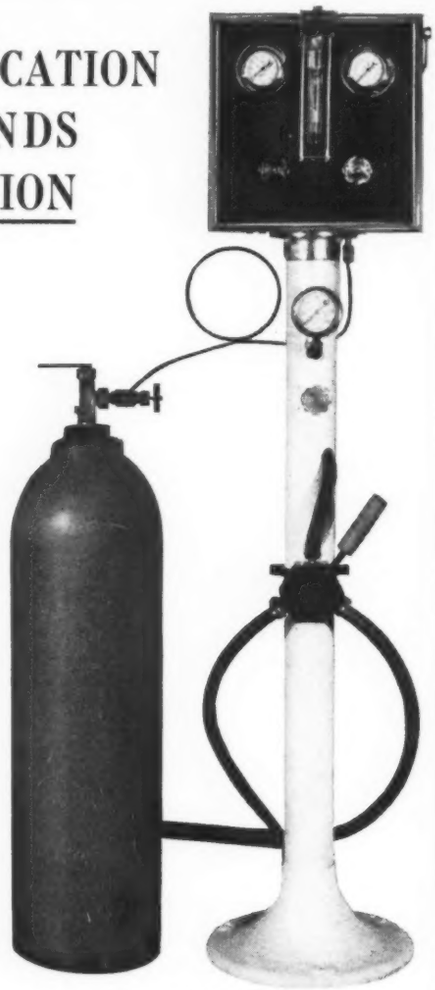

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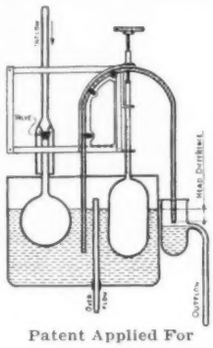

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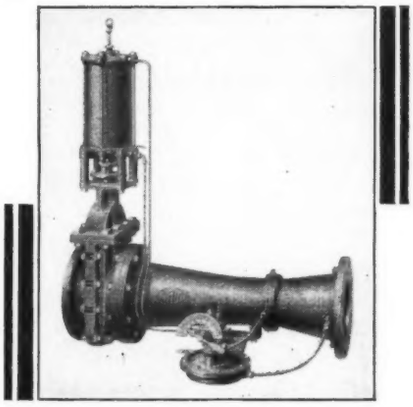

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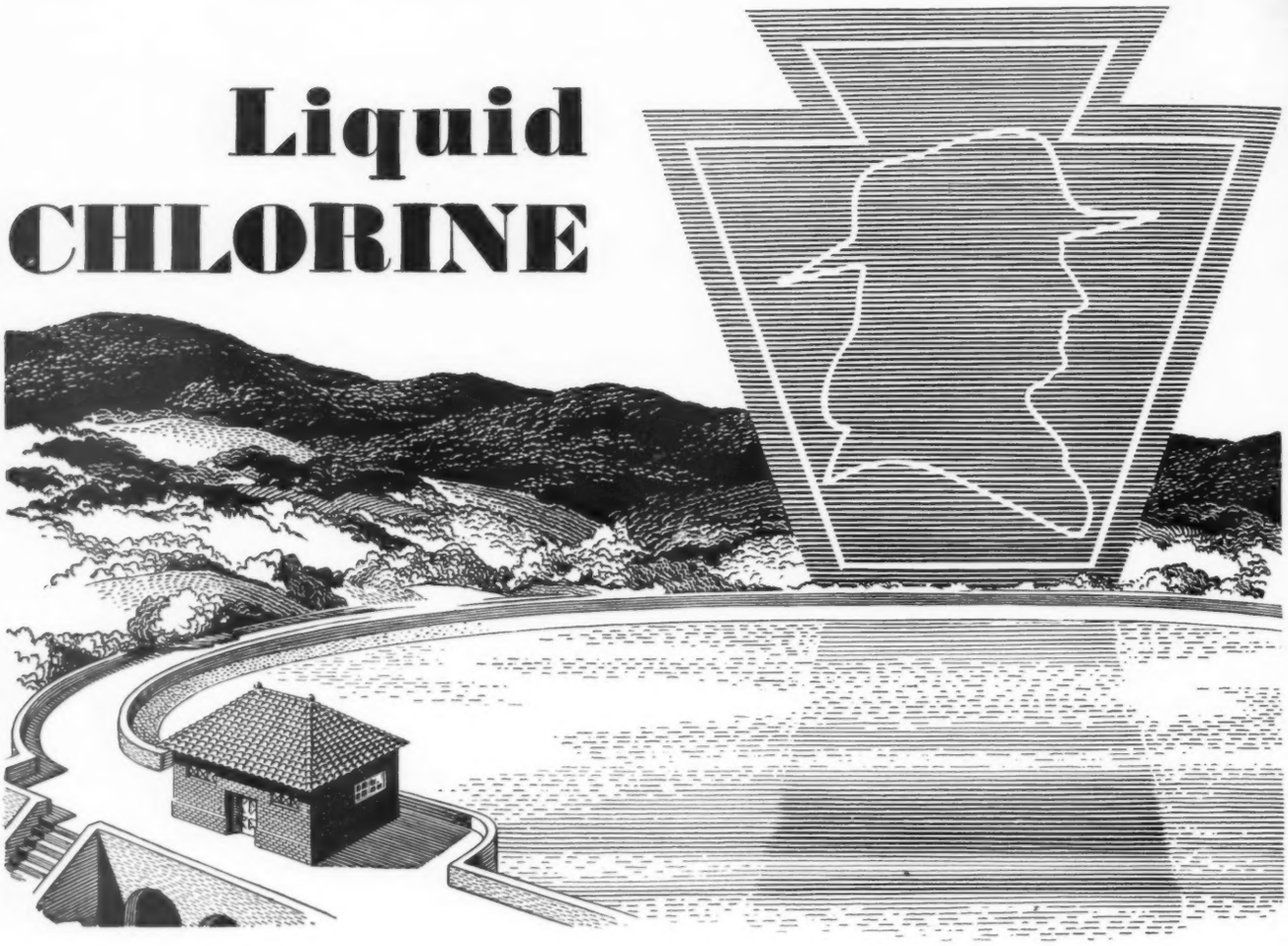

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WATER WORKS AND SEWERAGE
VOL. 80. NO. 9 SEPT. 1933
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A 4,000,000 GALLON ELEVATED STORAGE PROJECT

Solves Sheboygan's Distribution and Plant Operation Problems

By ARTHUR H. MILLER
Superintendent Department of Water Supply, Sheboygan, Wis.

Arthur H. Miller

THE advantages of elevated storage have probably been studied in connection with practically every water supply system. In recent years many additions in the nature of elevated tanks have been made in the larger cities, notably Detroit, Des Moines, Milwaukee, Minneapolis, Columbus and Indianapolis. In large systems the objective sought is generally twofold; namely, the elimination of peaks in the load curve, and the improvement of pressure conditions in areas served by such storage. In small systems intermittent pump plant operation is practiced and in such a system adequate elevated storage is obviously necessary. In cities of the size of Sheboygan, continuous pump plant operation prevails. When elevated storage is available in such a system, it serves mainly to smooth out the load curve and also to provide water during periods of unavoidable shut-down.

Preliminary studies of our problem at Sheboygan revealed that it might be possible through the construction of an elevated reservoir to secure the advantages outlined above for our system, which supplies a community of about 40,000 population. Even though this article deals necessarily with the Sheboygan problem, it is hoped that enough of general interest can be brought out to merit reading by engineers interested in water supply.

The Sheboygan Water Works Briefly Described

A water supply system for Sheboygan was constructed about 1888 by the American Water Works & Guarantee Co. A small pumping station was built on the shore of Lake Michigan and an 18-in. intake 1,200 feet in length drew the supply from the lake. Agitation for municipal ownership resulted in a valuation of the utility being made by the Wisconsin Public Service Commission, the property being purchased in 1909 by the city for $475,000.

Management of the system under municipal ownership has been vested in a water commission of three citizens appointed by the common council. The commission turns actual operation over to the superintendent and his staff. Since coming under city ownership, the facilities have been expanded to meet the growth of the city, which has had a population increase to 40,000 in 1930, it having been but 25,000 in 1909.

Plate 1 shows an outline map of the city, the main feeder lines in the water distribution system, and the pumping station and filter plant located in the northeastern section of the city. The recently completed elevated reservoir on Taylor Hill is also shown.

The filter plant was put into service March 1st, 1931. Briefly described, it is of the rapid sand type, having a capacity of 12 m.g.d. from 6 beds of 2 million each. A

clear water well of 1.75 m.g. serves as the filtered water reservoir.

Raw water enters the low lift pump suction well through a 30-in. C. I. intake line about 5,000 ft. long. An old intake 20 in. diameter and 1,800 ft. long is also

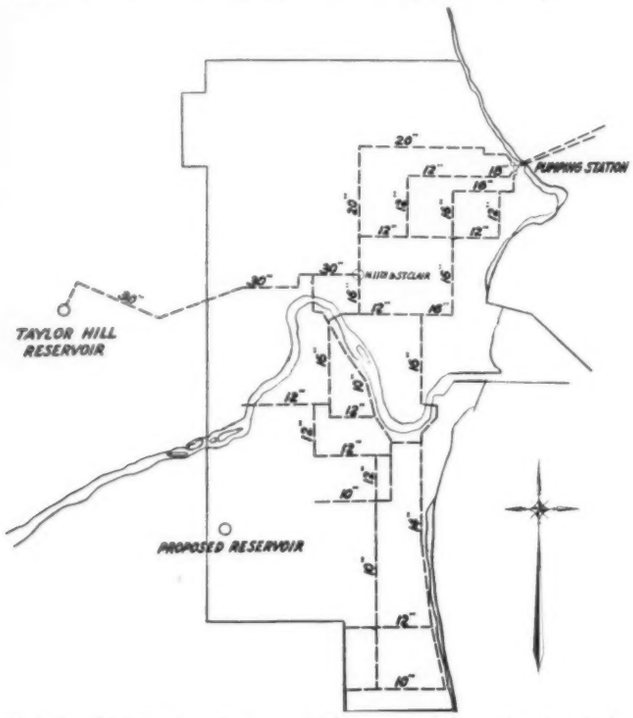

Plate 1—Distribution System of Sheboygan, Wis., Showing Principal Feeder Mains and Location of New 4 M.G. Elevated Reservoir on Taylor Hill. (Filter Plant Is Adjacent to Pumping Station)

available for periods of heavy draught. The combined capacity of these intakes at normal lake levels is 20,000,000.

High lift pumping equipment consists of one 12 m.g.d., E. P. Allis duples; one 8 m.g.d. Nordberg duplex and a 4 m.g.d. Holly pump of old design. These pumps deliver water to the distribution system under a normal pressure of 85 lbs. per sq. in., (a head of 196 ft.) and have a combined capacity of 24 m.g.d.

When the filter plant construction was being considered in 1929, the question of its capacity was given careful study. It was decided at that time that the addition of elevated storage was imperative and with it a capacity of 12 m.g.d. would be ample for some years to come.

Load Survey for System

During the decade beginning in 1920, the city of Sheboygan like many other Wisconsin cities enjoyed a growth somewhat more rapid than the normal average. Considerable industrial development took place, and this growth placed an ever increasing load on the water supply system. No additions to the pumping plant had been made since 1920, with the result that each year found the margin of capacity less, until, in 1929 the actual limit of capacity was reached on several occasions.

In 1920 only a small percentage of services were metered, while in 1929 about 60 per cent were metered. This increase in the percentage of metered services acted to bring down the consumption per consumer, as shown in Table I.

It is quite evident from a study of this table that without the increasing percentage of metered consumers, an enlargement of the plant would have been imperative before 1930.

TABLE I.

Year	Total No. Consumers	No. Meters	Per cent Metered	Average Daily Pumpage	Maximum Daily Pumpage	Gals. per Day per Consumer
1920.....	6,744	1,388	20.5	4.7 mgd	7.5	700
1921.....	6,949	1,575	22.6	4.9	9.24	707
1922.....	7,219	1,818	25	5.24	8.28	725
1923.....	8,222	2,498	30	5.7	9.6	692
1924.....	8,519	2,719	32	5.5	8.9	645
1925.....	9,090	3,620	40	5.6	8.27	615
1926.....	9,528	4,373	46	5.8	9.7	610
1927.....	10,034	5,091	48.5	5.7	8.4	568
1928.....	10,361	5,654	54.5	5.6	7.9	542
1929.....	10,660	6,033	57	6.12	11.9	572
1930.....	10,849	6,454	60	6.07	10.04	559
1931.....	10,851	7,105	66	5.58	10.9	515
1932.....	10,790	7,772	72	5.16	10.0	478

In a direct pumping system such as that at Sheboygan, the required plant capacity is of course determined by the maximum or peak requirements of the area served. In order to show the extreme variation in the daily load, the load curve for a hot day in August, 1931, is shown —see Plate 2. The location and extent of these "peaks" are largely determined by regulations which govern the sprinkling of lawns in Sheboygan. The following facts appear from a study of this load curve:

(a). Maximum "peak" rate is almost twice the average rate for the day.

(b). Maximum rate for the day is 5.7 times minimum rate.

(c). Maximum daily total is twice the average daily total for the year.

Adequacy of System to Handle the Load

Since the full plant capacity was utilized in meeting the more or less normal water demands of the city at times, it is evident that little or no reserve for fire fighting purposes was available.

During the period from 1923-1932 several well known water supply engineers have been called in, and all of them have agreed that the addition of elevated storage would best solve our problem. A study of Plate 2 indicates the theoretical quantity of water required in elevated storage to permit the operation of pumps at a uniform rate of 10,970,000 g.p.d. to be 1,045,000 gals., a

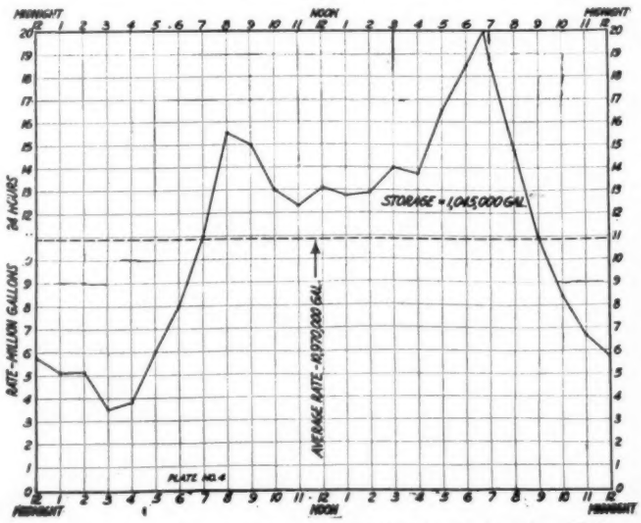

Plate 2—Rates of Pumpage (Consumption) Typical for Sheboygan, Wis., on a Hot Day in Summer. Taken from Water Readings at the Pumping Station

rather insignificant quantity when considering the improvement in plant operating conditions made possible. It will be seen that on this day the "maximum peak" was such as to tax the pumping plant to full capacity. Only the fact that the clear well storage was completely

filled in the early part of the day made it possible to deliver the quantity of water called for.

Solutions Considered

The deficiency in the then existing water supply facilities could obviously be corrected in more than one way. It has been shown in Table I that the gradual installation of meters had a marked effect in preventing wasteful use of water, and thus postponed the necessity for action for several years. Now, however, something had to be done to relieve the plants of peak loads.

The two general plans finally considered were: (1) Addition to the pumping plant in all its departments to expand output capacity about 50 per cent. (2) Addition of elevated storage of sufficient capacity to allow plant operation at a uniform rate in spite of the extreme variations in demands known to exist.

section of only slightly less elevation was next in the matter of poor pressure conditions. The minimum static head for acceptable water service in the entire city has been fixed at 200 ft., equivalent to about 87 lbs. per sq. in. after years of operation. An estimate of a 1,500,000-gal. steel tank on steel tower at the location of "proposed reservoir" shown on Plate 1 in the southwestern section of the city was worked out. The cost of this structure with the required connecting trunk water line was found to be $155,000. While such a reservoir would be of material help in solving our problem, it is now quite well established that in order to "float on the line" a reservoir or elevated storage equal to 30 per cent of the maximum daily pumpage must be provided. When storage is provided in a lesser percentage the flow from the tank must be controlled.

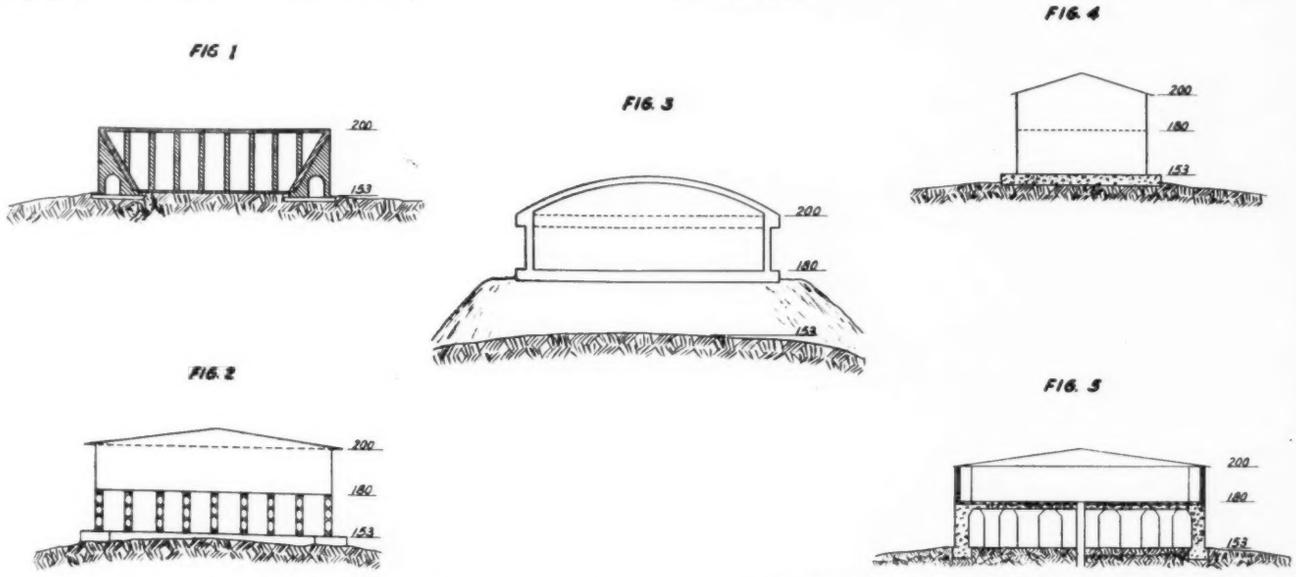

Fig. 3—Sketches of Various Reservoir Designs Investigated

In order to expand the output capacity of the plant by 50 per cent, the following additions were shown to be necessary: (1) 36 in. cast iron intake line 5,000 ft. long at a cost of $160,000, including laying, interconnection, intake crib and suction well additions. (2) Three filter beds with necessary sedimentation and storage basins and piping and equipment at a cost of $140,000. (3) High lift pumping additions and alterations $90,000. The total expenditure for this plan was $390,000. Increase in fixed charges—interest, depreciation and taxes were estimated at $35,000 yearly. Production or output costs of water would be increased slightly.

Elevated storage has been added to water supply systems largely in accordance with certain topographical characteristics existing in the area served. When the topography is comparatively flat, steel tanks of a capacity not to exceed 2,000,000 gal. have been elevated upon steel towers to give the desired head. Recent examples of this type can be found in the cities of Milwaukee and Detroit. When the topography is irregular, a location giving the required head above the area served is chosen and a reservoir built on the surface or underground at this location. In Sheboygan either of these solutions were possible and both were therefore quite fully investigated. Referring again to Plate 1 we wish to point out that the southwest section having the maximum elevation within the city boundaries, namely 83 ft. above datum or mean lake level, had also the poorest water pressure conditions in the area served. The northwest

Assuming that the present pumping station is capable of a maximum daily output of 15,000,000 gal., it appears that about 4,000,000 gal. would be the required elevated storage capacity eventually needed. By locating another elevated tank of equal size in the northwestern section of the city, it would have been possible to achieve the desired results in a modest way. The total cost of these two elevated storage structures would be roughly $300,000. Structures of this type are generally recognized as being somewhat unsightly and subject to maintenance costs in the nature of painting.

Just west of the city plat was a higher section of terrain (Taylor Hill on Plate 1), which is approximately 10,000 ft. from the center of distribution. The maximum elevation on Taylor Hill is 155 ft. and it was at once apparent that this site possessed the essentials of a suitable reservoir location.

In the early part of 1932 preliminary plans and estimates revealed the practicability of building a 4,000,000-gal. reservoir structure of pleasing appearance, and the required 30-in. cast iron connecting main to the center of the distribution system, for approximately $225,000. It was then decided that this was the correct solution of our problem. A complete design of the project was prepared and work was pushed forward rapidly.

Taylor Hill Reservoir, Design and Construction

Having decided on the location of the reservoir structure, the task was made more definite. In order to provide the desired static head of 200 ft., it was necessary

THE JERRY DONOHUE ENGINEERING CO. — SHEBOYGAN WATER DEPARTMENT TABULATION OF BIDS 4,000,000 GAL. RESERVOIR — SEPTEMBER 23, 1932

ITEM 1 (CONCRETE SUBSTRUCTURE)

CONTRACTOR	NO OF KEY MEN	COMPLETE STRUCTURE	1 GRADING PER YD	2 EARTH BORROW PER YD 5000 YD	3 FOOTING EXCAV PER YD	4 EXTRA FOR WINTER CONCRETE PER YD	5 FOOTING CONCRETE PER YD	6 COLUMN CONCRETE PER YD	7 GIRDER CONCRETE PER YD	8 FLOOR SLAB CONCRETE PER YD	9 REINF STEEL PER LB IN PLACE	10 FORMS PER SQ FT	IF BRICK CURTAIN WALL IS OMITTED DEDUCT	
ZIMMERMANN & ZIMMERMANN WAUWATOSA, WIS.	5	74,807.00	.50	.50	.50	.50	7.00	8.00	10.00	8.00	.023	.14	16,500.00	
PERMANENT CONST CO MILWAUKEE, WIS.	5	78,963.00	.30	.50	.50	1.10	5.87	6.37	6.37	6.37	.0234	.26	11,660.00	
VAN WAGNER CONST CO PLYMOUTH, WIS.	3	63,964.00	.50	.45	.80	9.00	9.00	9.00	9.00	9.00	.05	.20	10,227.00	
BORTH, UEHLSTORF & MEYER SHEBOYGAN, WIS.	0	78,400.00	.45	.45	.80	—	7.00	7.00	7.00	7.00	.025	.20	9,500.00	
IMMEL CONSTRUCTION CO. FOND DULAC, WIS.	5	64,343.00	.30	.50	.75	1.50	7.90	8.90	8.40	8.40	.035	.16	12,820.00	
ROBT REISINGER & CO MILWAUKEE, WIS.	6	86,621.00	.50	.45	1.10	2.00	6.55	7.30	7.15	7.15	.03	.28	13,316.00	
FRANK GUENTHER SHEBOYGAN, WIS.	0	81,888.00	.40	.40	1.20	1.20	6.90	7.25	7.25	6.90	.03	.20	NO BID	
G. R. FEHR, INC MILWAUKEE, WIS	4	85,803.00	.35	.90	.40	1.00	7.50	12.00	12.00	12.00	.03	.12	16,223.00	
CITY CONSTRUCTION DEPT SHEBOYGAN, WIS	0	65,400.00	.40	.25	1.00	.75	5.50	5.50	5.50	5.50	.026	.20	13,500.00	
PITTSBURGH DES MOINES CHICAGO, ILL.			.50	1.00	.50	1.25	11.00	18.00	18.00	20.00	.03	.50		

ITEM 2 (STEEL TANK)

CONTRACTOR	NO. OF KEY MEN	1 STEEL TANK COMPLETE	2 IF OVERFLOW IS OMITTED DEDUCT
WIS BRIDGE & IRON WORKS MILWAUKEE, WIS	2	39,890.00	250.00
A O SMITH CORP MILWAUKEE, WIS	14	70,095.00	1380.00
GRAVER TANK & MFG CO EAST CHICAGO, IND	10	41,112.00	257.00
PITTSBURGH DES MOINES CHICAGO ILL	4	40,500.00	500.00
GEELE HARDWARE CO SHEBOYGAN, WIS	25	38,700.00	—
CHICAGO BRIDGE & IRON CHICAGO, ILL	4-6	39,100.00	375.00
CHICAGO BRIDGE & IRON CHICAGO, ILL	4-6	37,300.00	375.00

ITEM 2A (STEEL TANK ON ALTERNATE STEEL SUBSTRUCTURE)

CONTRACTOR	NO OF KEY MEN	COMPLETE TANK WITH STEEL SUBSTRUCTURE	IF BRICK CURTAIN WALL IS OMITTED DEDUCT	IF OVERFLOW IS OMITTED DEDUCT	
WIS BRIDGE & IRON WORKS MILWAUKEE, WIS	3	116,000.00	10,300.00	250.00	
PERMANENT CONST CO MILWAUKEE, WIS	5	157,946.00	15,274.00	1380.00	
NOTE DEDUCT 1000.00 FOR WELDED BOTTOM					
	4	123,800.00	13,800.00	500.00	CONCRETE CURTAIN WALL INSTEAD OF BRICK 1,600.00
RIVETTED BOTTOM	4-6	124,065.00	24,285.00	375.00	
WELDED BOTTOM					

Plate 4—Tabulation of Bids on Substructure and Steel Tank for 4 M.G. Elevated Storage Reservoir at Sheboygan, Wis.

to add an elevation of 45 ft. to the existing natural ground elevation of 155 ft. Actually the ground elevation was taken as being 153 ft. to facilitate grading around the structure. Having determined to build a reservoir of 4,000,000 gals. available capacity, the 20-foot range of head was selected to be between 200 and 180 ft.

The simple drawings on Plate 3 show the various types of construction were investigated from the viewpoints of adaptability and cost. We will discuss each design briefly, pointing out the desirable and undesirable features as they appeared to us.

Concrete (Fig. 1, Plate 3)

A reinforced concrete reservoir built on the ground was one of the first considered. It could be made architecturally pleasing if not beautiful but would prove difficult to make and keep water tight under the head of 43 ft., and was high in cost. In order to have 4,000,000 gal. available between elevation 200 and 180 ft., the total contents would be approximately 8,000,000 gal. This design was not seriously considered.

Steel Standpipe (Fig. 4)

Next considered was a cylindrical steel shell (conical roof) built on the ground and supported on a circular slab of concrete. While this appears to be a simple, cheap way of providing the storage of 4,000,000 gal. between the specified head limits, such does not prove to be true. The inside diameter required was 185 ft. Such a shell under the head of 47 ft. would involve plate thicknesses entirely impractical, and therefore bring up the total weight of steel to enormous figures. The cost was extremely high. The structure would be unsightly, subject to large upkeep costs from painting, and in general open to most of the objections of the concrete tank. This design received preliminary consideration only.

"Hewett Type" Concrete (Fig. 3)

Another type of reservoir considered was that of hooped concrete construction, sometimes referred to as the "Hewett type." Essentially this consists of a cylindrical concrete shell with domed roof and flat bottom in which the tension stresses are entirely carried by steel hoops. After the concrete wall has been built, these hoops equipped with turnbuckles are drawn up until they carry a predetermined initial stress high enough to offset the tensional stresses that result from the water pressures and the thrust of the roof. A considerable number of these structures have been built during recent years, both for oil and water storage. The city of Minneapolis has recently completed a reservoir of this type with a capacity of 1,750,000 gals. In adopting this design it would have been necessary to raise the ground elevation at the site to 180 ft. This we proposed to do by mounding an earth fill to the required height. Preliminary estimates were worked up and the cost of this structure was fixed at $165,000. The high cost, together with the fact that in large diameters the design was somewhat experimental, eliminated this type from further consideration. It is our opinion that where ground elevation is such as to require no artificial mound, and where diameter and height are moderate, this type of structure deserves serious consideration.

Elevated Steel Tank (Fig. 2)

The steel tank on a tower is the most common type

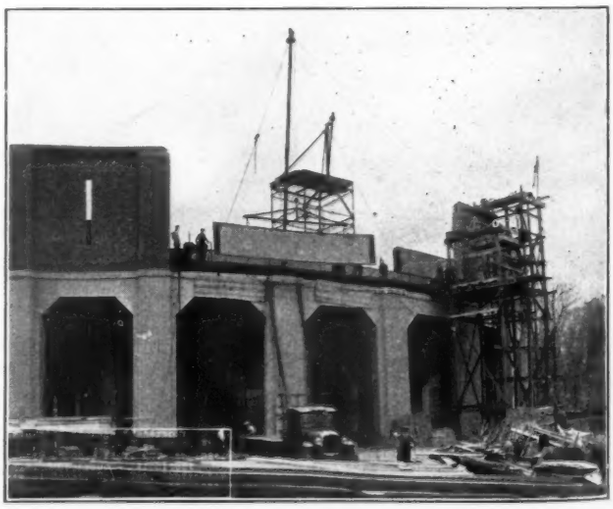

Plate 5—View Showing Construction of the Tank and Masonry Structures. Bottom Welded; Sides Riveted

of elevated water reservoir structure. This would have consisted of a steel shell 185 ft. in diameter and 20 ft. deep, supported on structural steel columns and concrete footings. In its actual construction the bottom supported on steel beams would of course not be flat, but would be curved downward between the beams, giving a somewhat fluted appearance to the bottom. The roof in this design is conical, of steel and supported on trusses and columns or rafters, purlins and columns. The design was not satisfactory from the standpoint of appearance and high upkeep costs. Several of the larger tank builders were so positive that this was the most economical design that they asked to be allowed to bid on this type as an alternate to the accepted design. These bidders agreed to prepare proposal drawing showing such architectural treatment as would overcome the objections as to appearance. When the bids were totaled, it was found that the cost of this type was considerably higher than that of the accepted design, even after deducting all extras for architectural screening. See Plate 4.

Selected Design: Steel Tank on Concrete Columns (Fig. 5)

We come now to the design selected. It is believed that this structure as built has several features that warrant some detailed description. In its elements this structure consists of the following:

(a) A circular flat concrete slab 196 ft. in diameter, supported on reinforced concrete piers and columns.

(b) A shallow cylindrical steel tank 185 ft. in diameter with a 20 ft. effective depth, and a conical steel roof with long projecting eaves.

(c) A brick envelope wall erected on the outer perimeter of the slab and closing up under the steel roof. This wall is approximately 3 ft. from the steel tank, so as to provide a circular passage way around the tank. A steel stairway from the ground level leads to the floor level and provides access to this passage way. Plate 5 shows the tank and walls under construction and Plate 7 the completed structure. The exterior design featuring the massive pier faces and rather bold pilasters of the brick wall, are supplemented by narrow high window openings. Cap stones on the pilasters, together with a brick capping course at the top further enhances the appearance.

Plate 6 shows the reinforced concrete footings and sub-structure. Excellent bearing quality of the subsoil made piling unnecessary. Bearing values of the ground were taken at 6,000 lbs. per sq. ft. and observations taken during construction show practically no settlement. Further observations will be made as the water load is added.

The steel tank itself is of simple design. The bottom and roof are of welded construction but the side plates

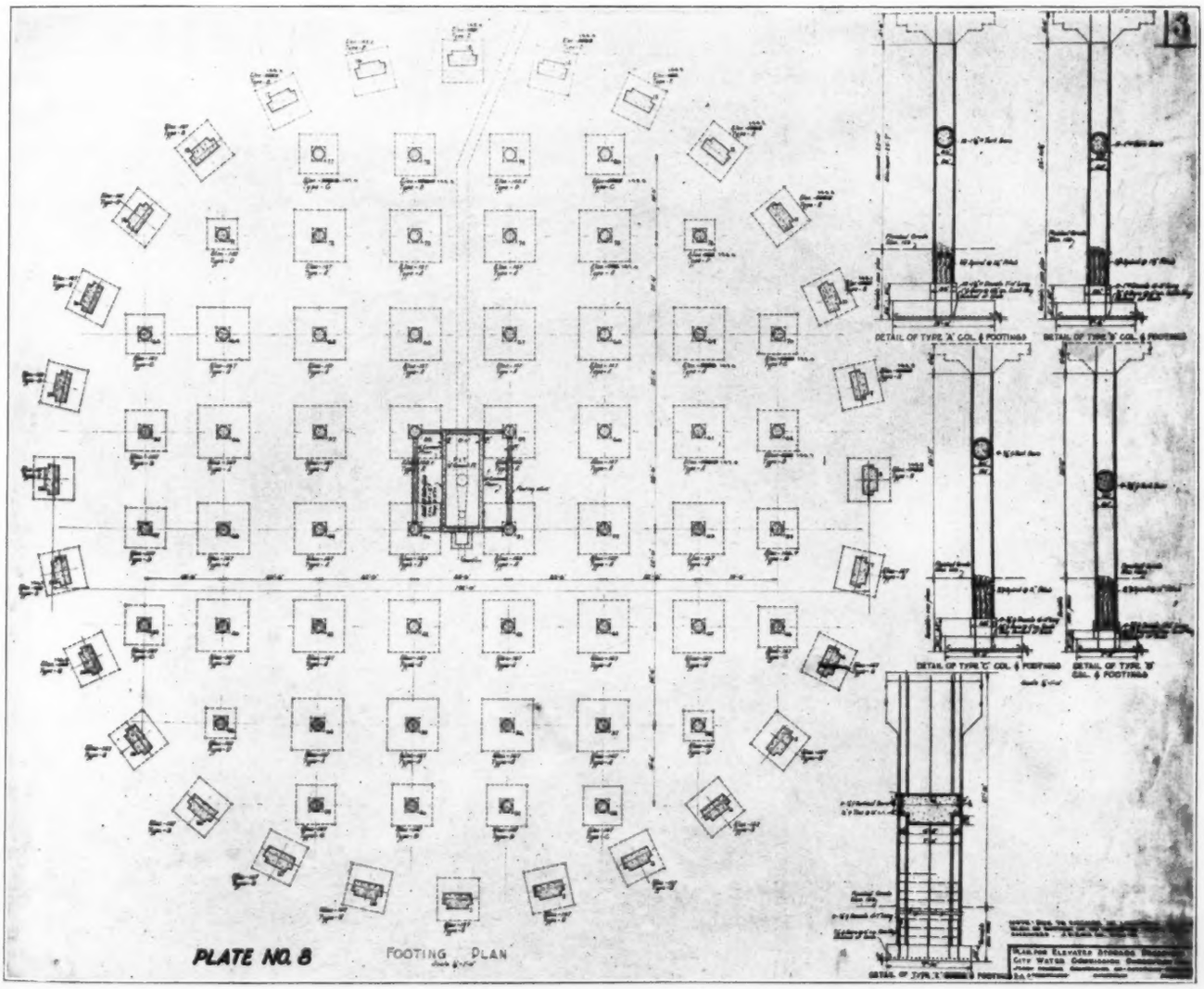

Plate 6—Reinforced Concrete Substructure and Footings

are riveted. Plate thickness is as follows: Bottom 5/16 in., 1st course 7/8 in., 2nd course 21/32 in., 3rd course 7/16 in., 4th course 5/16 in., roof 3/16 in. Bottom plates are lap welded with the exception of the marginal plates which are butt welded. Roof plates are all lap welded. The welding is done by the Fleet-weld method. The joint between 1st course plates and the bottom plate is welded on inside and outside. The roof is supported by structural steel columns, plus the usual purlins and rafters. The steel bottom is laid on a 2-in. thick cushion of beach sand. There is a bottom slope of 6 inches from the outside to the center to allow drainage into the 30-in. diameter riser pipe when emptying the reservoir. A concrete curb 2 in. away from the outside of reservoir bottom and 4 inches high provides space for a mastic seal. Condensation on the outside surface is carried away over this seal to weep holes through the concrete slab.

Directly under the center of the structure is provided a pit to house the riser pipe and overflow pipe fittings, together with drain valve and sewer outlet. In this pit is also installed an 18-in. automatic altitude valve, supplied by the Automatic Cone Valve Company, of Mattoon, Ill., which acts to close the inlet pipe when the water has reached the 200 ft. elevation level in the reservoir and to again open automatically when a loss of 10 ft. head is registered on the city side of the valve. This valve is guaranteed to close within 3 in. of the elevation for which it is set.

An Esterline-Angus level recording device will transmit the variations occurring in the water level in the reservoir to a recording chart in the pumping station about three miles distant. Essentially this device is made up of three parts: a transmitter located in the pit house, a telephone wire circuit to the pump house and a recording set also at the pump house. From the "strip" type chart on the recorder can be noted (1) The elevation of the water in the reservoir; (2) The rate at which the water is entering or leaving the reservoir; (3) The instant of closure or opening of the automatic valve under the reservoir. This chart enables the engineer at the pumping station to regulate his operations so as to utilize the reservoir to the best advantage in balancing the load on the system.

A tabulated list of the bids taken for the complete reservoir are included (Plate 4), and may be of some interest to readers. The general contract was taken by the Immel Construction Co. of Fond du Lac, Wis. The tank work was awarded to the Chicago Bridge & Iron Co. of Chicago, Ill., and the main laying contract to the Utility Construction Co. of Sheboygan, Wis. Work was started in October, 1932, and completed in July, 1933.

With the addition of this much needed storage facility the pumping schedule will be radically altered so as to secure the greatest possible benefits.

The pumpage at present varies from a low of 3 m.g.d. in the winter to a maximum of 10 m.g.d. during hot dry weather. During six months or more of the year the pumpage is 6 m.g.d. or less. It is now proposed to shut down the pumping and filter plant during this low pumpage period for at least 8 hrs. each day, and possibly 12 hrs. during a part of this period. By choosing the proper high lift pump, it should be possible to operate at maximum efficiency during all times.

The maximum operating pressure at the high lift pumps should be less than 100 lbs. per sq. in. The normal pumping pressure will be about 90 lbs. per sq. in. Satisfactory water pressures throughout the city will be realized under all conditions. Since the reservoir location places the entire city plat between the pumping station and the reservoir, this should result in an improvement in pressure conditions throughout the area during periods of maximum flow, as the supply at such times will be from both sources and result in lower velocities in the system. The location of the reservoir is ideal from the standpoint of future city growth.

It is hardly necessary to point out that in addition to the increased economies in high lift pumping there are many others possible. An estimate of all the possible savings totals $4.00 per million gallons pumped. For 1932 the total pumpage was 1,800,000,000 gals. On this basis the yearly savings are $7,200.00 in operating costs. This sum is almost sufficient to care for interest charges on the cost of the entire reservoir project.

The overall capacity of the pumping and filter plant

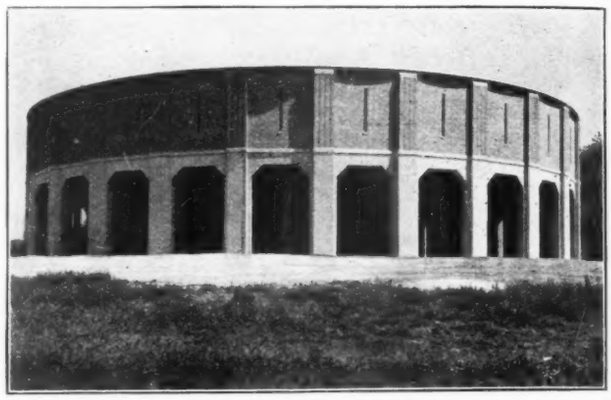

Plate 7—The Completed Structure (Roof of Conical Steel Construction Does Not Show in This View)

with the reservoir in service should be 12,000,000 gals. of water per day for continuous operation and 15,000,000 gals. for a few days in succession during periods of excessive use. Assuming the present liberal per capita consumption of 250 gals. on maximum or peak days, the system should be able to supply a population of 60,000 people, which at the present rate of growth this will be the population of Sheboygan in 1955.

The reliability of the service will be greatly improved. With the reservoir filled the pumping plant could be shut down and at a 12 m.g.d. fire rate water would be available for fire fighting for at least 6 hours. It is expected that this improvement will ultimately result in an improved rating by the Insurance Underwriters and a corresponding saving to policy holders in this city. With the reservoir "floating" on the distribution system, forced shut down of the water plant will no longer have serious consequences. It is quite likely that shut downs will be entirely unnoticed by the patrons. The possibility of damage to mains and pumps from excessive water pressure will be eliminated.

We believe that we have shown conclusively that in adding elevated storage to the water supply system of Sheboygan, Wis., a pressing problem has been solved most economically, and that the resulting improvements in service will reward us generously.

After basic designs and calculations had been completed by the author, The Jerry Donohue Engineering Co. of Sheboygan, Wis., were engaged as consultants. Working plans and specifications for the reservoir were prepared by them with the assistance of Edgar Stubenrauch, Architect. Prof. W. S. Kinne, University of Wisconsin, checked the reinforced concrete design and calculations. Grateful acknowledgment to all the above is hereby made. Working drawings and specifications for the 30 in. pipe line were prepared in the office of the water department. Bids were taken and tabulated by the Jerry Donohue Engineering Co., who also acted as arbitrator between the contractor and the board of water commissioners.

GRIT AND SCREENINGS INCINERATION PLANT AT MILWAUKEE, WIS.

By DARWIN W. TOWNSEND, C. E.

Principal Assistant Engineer, Sewerage Commission of Milwaukee, Wis.

INASMUCH as this article will deal, for the greater part, with the design and character of the plant constructed for the purpose of incinerating screenings and grit, and its various appurtenances, only such references will be made to matters of operation as may be necessary in instances to show reasons for certain design features and arrangement. The plant was completed late in the summer of 1932. Following a period of trial and adjustment, it was placed into routine service about the middle of November, since which time it has been operating continuously.

D. W. Townsend

It may be of interest to present at this point something relative to events preceding the final decision to dispose of sewage grit and screenings by incineration.

Reasons for Adopting Incineration

As far back as 1926, the year following that in which the Milwaukee sewage treatment plant was placed in operation, a recommendation was made to design and construct a plant for the incineration of screenings only, the matter of including grit not having been considered at that time. Owing to an unavoidable combination of various circumstances, however, action at that time was deferred, and the former practice of depositing grit and screenings in piles upon the plant tract was continued.

The 1926 recommendation contemplated the partial dehydration of the screenings in Worthington filter presses of the Berrigan type, followed by destruction in some form of incinerator best suited for the purpose as visualized. Later, steps were taken toward attempting the burning of dehydrated screenings in sludge drying furnaces, two Berrigan filter presses having been used for dehydration preceding the burning process. Mechanical and operating difficulties warranted the abandonment of this scheme which was practiced a short time only.

During 1927 thought was given to the matter of disposal of screenings by digestion, a series of small scale laboratory tests having indicated the desirability of conducting further tests upon a more elaborate scale to determine, if possible, whether or not this method might be feasible from the standpoint of practical operation. A description of the screenings digestion plant which was subsequently designed and constructed, together with an outline of the analytical results obtained in the original small scale test units, is given in a paper presented by Dr. Willem Rudolfs and the writer before the American Society of Municipal Improvements at the Detroit convention in October, 1928, Dr. Rudolfs at that time having been retained by the Sewerage Commission as special consultant upon this particular problem.

After a period approximating one and one-half years, during which time a wide range of temperature and pH control were investigated and also during which time many changes in mechanical equipment and various other appurtenances were made, the experiment was abandoned, it having been concluded as far as the work had progressed that its application upon a large scale appeared to be impracticable.

For several years past the coarse sewage screenings, which are collected on bar screens, and which are relatively small in quantity, have been burned in one of the sludge drying furnaces, the partial dehydration prior to burning having been accomplished for the first two or three years by use of a Coffin vertical basket type hydraulic press and later, as well as at present, by use of a Tolhurst horizontal centrifugal machine of the laundry type.

The practical advantages which appeared to be present in the process of dehydrating coarse screenings in a centrifugal machine were sufficiently interesting to warrant trials upon its further application to the dewatering of the finer screenings which are relatively large in quantity and which are collected upon revolving drum screens having 3/32-inch slotted openings. The trials conducted in this connection indicated the practicability of adapting this type of unit to the dewatering of all of the screenings and also the grit.

A trial involving mixing of grit with screenings resulted in lessening the centrifuging time required when dewatering screenings alone, and from this standpoint appeared to be advantageous. It may be stated here that the grit produced at the Milwaukee treatment works is of a highly putrescible nature, unfit to be deposited upon land without some form of treatment. Rather elaborate experiments upon grit washing, the only treatment method

The problem of disposing of fine screenings at sewage treatment plants has been a troublesome one for many years—in fact has been the cause of nuisance in numerous instances.

In determining on a procedure of disposing of fine screenings at the modern treatment plants constructed by the Westchester County Sewer Commission incineration was resorted to and has proven successful. An article on this topic by W. W. Young, Consulting Engineer to the Westchester Commission, appeared in WATER WORKS AND SEWERAGE for June, 1932.

Milwaukee has gone further and incinerates grit mixed with screenings, as described in this article. And Los Angeles has recently let contracts for, what will be, the largest screenings incineration plant in the world. It therefore appears that incineration is the most practical as well as the most sanitary and nuisanceless means that has yet been devised for disposal of such obnoxious materials.

The present article by Mr. Townsend will be followed by another of equal or even greater interest—one that will disclose operating and cost data, which is now becoming available at Milwaukee.—Editor.

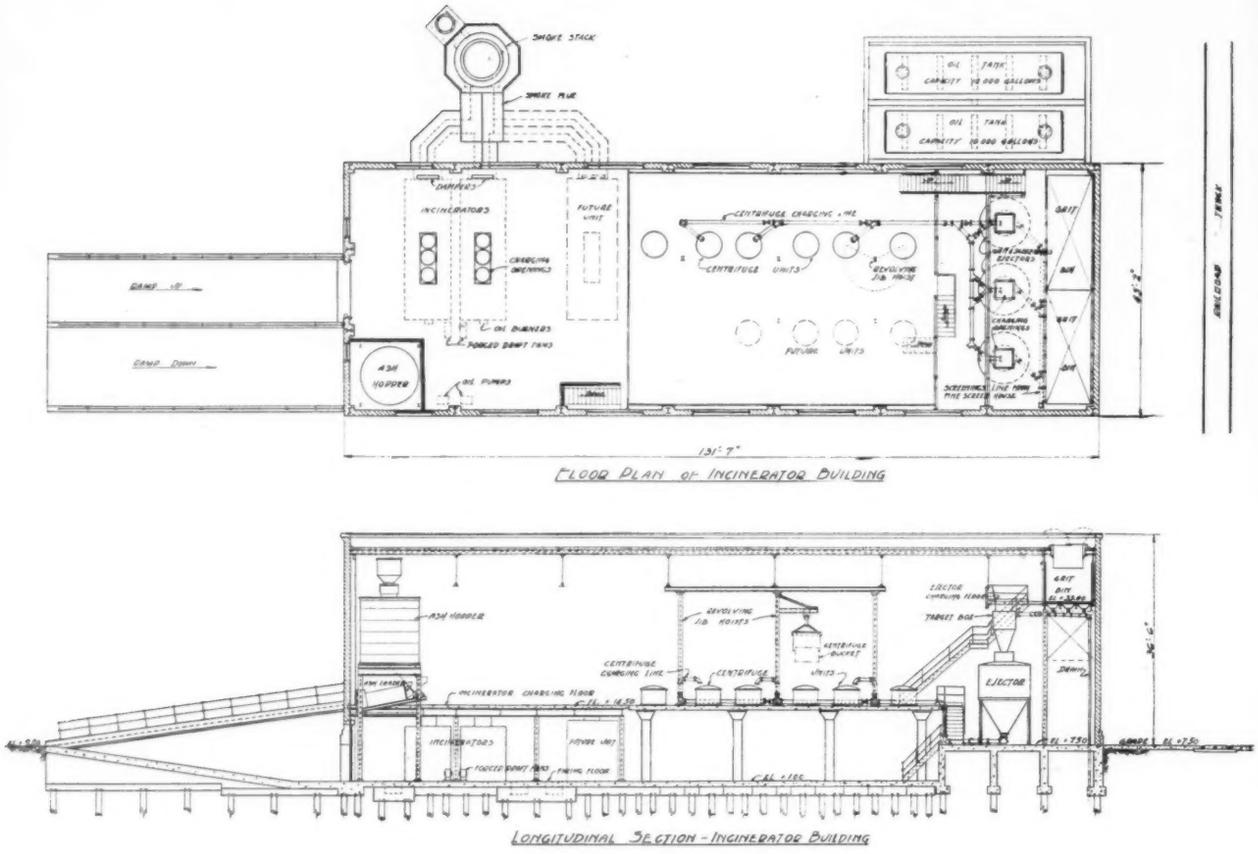

Fig. 1—General Arrangement of Incinerator Building, Sewage Treatment Works, Milwaukee, Wis.

given consideration, were conducted during 1928. The results, from an economic and practical operation standpoint, were not sufficiently encouraging to warrant the adoption of this process.

It, therefore, appeared advisable, all angles to the problem as a whole considered, to combine screenings and grit, centrifuge them in horizontal centrifugal machines, and finally resort to their complete and permanent destruction through the use of incinerators. The resulting inert ash from the procedure (about 25 per cent, by weight, of the dry material preceding incineration) being an inodorous product we felt could be deposited upon land without nuisance from unsightliness and odors resulting.

The sewage treated at the Milwaukee plant is for the greater part collected in a system of combined sewers. Coarse screenings, fine screenings and grit, from an analysis of available data, were shown to be collected at rates of 150 pounds, 975 pounds, and 325 pounds, respectively, per million gallons of sewage, the respective moistures being 88, 92, and 55 per cent. After centrifuging, the above unit weights when considered separately, are 54 pounds, 363 pounds, and 243 pounds, the respective corresponding moistures being 61, 78, and 40 per cent.

Reference to Table I will show the relative quantities of materials to be dehydrated and incinerated, the extent of plant initially provided being adequate to handle the collected materials from an average sewage flow of 110 m.g.d., this being the predicted 1935 flow which may be treated in the treatment plant following the completion of proposed extensions. The sewage flow through the present plant is at the average rate of 85 m.g.d. only.

Selection of Proper Type of Incinerator

The problem of selecting a type of incinerator suitable for burning material of this particular character gave considerable concern, and several incinerator installations were inspected, with the ultimate result that the type of unit as manufactured by the Morse Boulger Company, of New York, was selected for use. Large-scale tests conducted in a nearby incinerator of the garbage type demonstrated rather conclusively the futility of expecting that any unit of the iron-grate type would give satisfactory performance. The high silica content of the mixture of screenings and grit, due largely to the presence of the grit which, when subjected to the temperature necessary, fused at such a rate and in such quantity as to render the grate entirely useless. This fusing upon the grate would not only shut off the air supply almost completely, but would also destroy the grate.

In the two units, having capacities of 20 tons each per 24 hrs., grates are entirely absent, and in their place refractory materials are used. It was reasonable to expect that with such materials, fusing would to a large extent be eliminated. The design offered by the Morse Boulger Company embodied the following principal features:

1. The sloped and drained charging floor is unobstructed. With three charging holes per unit, this arrangement renders introduction of the material relatively easy. Furthermore, charging in three places means that the material will be somewhat spread out before entering the incinerator proper.

2. There are approximately 105 sq. ft. of refractory surface area per ton of capacity. It will be recalled that

TABLE I

A—Fine Screenings to be Incinerated, in Pounds per Day.

	110 M.G.D.....1930				153.75 M.G.D.....1945				196.25 M.G.D.....1960			
	Av.	Max. 6 Mo.	Min. 6 Mo.	Max. Month	Av.	Max. 6 Mo.	Min. 6 Mo.	Max. Month	Av.	Max. 6 Mo.	Min. 6 Mo.	Max. Month
Wet material	83,600	107,250	61,820	114,730	116,850	144,906	86,407	160,361	149,150	191,344	110,292	204,689
Centrifuged material	31,020	39,930	22,990	41,360	43,357	55,811	32,134	57,810	55,342	71,239	41,016	73,790
Water to be evaporated	24,420	31,350	18,040	32,560	34,132	43,819	25,215	45,510	43,567	55,931	32,185	58,090
Ash	880	1,320	495	1,694	1,230	1,845	692	2,368	1,570	2,355	883	3,022
Volatile matter	5,720	7,260	4,455	7,106	7,995	10,147	6,227	9,932	10,205	12,952	7,948	12,678
B—Coarse Screenings to be Incinerated, in Pounds per Day.												
Wet material	16,280	.....	.....	.....	22,755	.....	.....	.....	29,045	.....	.....	.....
Centrifuged material	5,940	.....	.....	.....	8,302	.....	.....	.....	10,597	.....	.....	.....
Water to be evaporated	3,960	.....	.....	.....	5,535	.....	.....	.....	7,065	.....	.....	.....
Ash	330	.....	.....	.....	461	.....	.....	.....	589	.....	.....	.....
Volatile matter	1,650	.....	.....	.....	2,305	.....	.....	.....	2,945	.....	.....	.....
C—Grit to be Incinerated, in Pounds per Day.												
Wet material	31,680	35,640	27,830	51,370	34,056	38,313	29,917	55,223	36,432	40,986	32,004	59,075
Centrifuged material	23,870	26,730	20,900	38,830	25,660	28,735	22,467	41,742	27,450	30,739	24,035	44,654
Water to be evaporated	7,810	8,910	6,930	12,540	8,396	9,578	7,450	13,480	8,982	10,246	7,969	14,421
Ash	7,700	8,470	6,930	13,530	8,277	9,105	7,450	14,545	8,855	9,740	7,969	15,559
Volatile matter	6,600	7,370	5,940	9,900	7,095	7,923	6,385	10,642	7,590	8,475	6,831	11,385
D—Total Amount of Material to be Incinerated, in Pounds per Day.												
Wet material	131,560	159,170	105,930	182,380	173,661	205,794	139,079	238,339	214,627	261,375	171,341	292,809
Centrifuged material	60,830	72,600	49,830	86,130	77,319	92,848	62,903	107,854	93,389	112,575	75,648	129,041
Water to be evaporated	36,190	44,200	28,930	49,060	48,063	58,932	38,200	64,525	59,614	73,242	47,219	79,576
Ash	8,910	10,120	7,755	15,554	9,968	11,411	8,603	17,374	11,014	12,684	9,441	19,170
Volatile matter	13,970	16,280	12,045	18,656	17,395	20,375	14,917	22,879	20,740	24,372	17,724	27,008

the water in the material is enclosed in the cell structure; therefore, by providing this large surface area, it is possible at one and the same time to spread out the material and to break down the greatest number of these cells, as well as to gain a large evaporating and heat absorbing surface.

3. Many stoking doors are provided for ease of accessibility to all parts of the unit.

4. Inasmuch as the elimination of odors from the burning process is an important matter, a long path for the travel of the gases has been provided, the units are long and narrow, and the refractory burning surfaces are relatively near the arches above them, which should result in forcing the heat downward and into the material.

Other points worthy of comment and which were considered of material importance by the Commission's engineers having to do with this design are:

1. The retention of the volatiles in contact with refractory materials for a comparatively long time.

2. The furnishing of an ample supply of air for combustion, not directly to the volatiles, but rather in such a way that the air is hot when it hits the burning gas. This feature is important where smoke, soot, and odor are to be eliminated.

3. The destructor being designed long and narrow, the scrubbing action of the flame entering from the end opposite the flue is exerted at every point within the incinerator, except in the last ash settling chamber, where the gases are expanded.

Theoretical Heat Balance

There is present in one ton of the centrifuged screenings and grit, containing about 65 per cent moisture, 1,300 pounds of water. The heat required to raise this quantity of water to steam at 1250° Fahrenheit is equivalent to about 2,127,000 B.t.u. The heat required to raise the 280 lbs. of ash per ton (14 per cent of the centrifuged volume) to 1250° Fahrenheit is 61,000 B.t.u. That required to raise the 420 lb. of combustible matter (21 per cent), combined with about 23 lb. of air to be supplied per pound of combustible, is 2,930,000 B.t.u. The heat calculated to be lost through radiation is about 300,000 B.t.u. By addition the total heat required is theoretically established at 5,418,000 B.t.u. per ton.

From analyses made in our laboratories, it has been estimated that each pound of combustible centrifuged material will contain about 9,000 B.t.u. That multiplied by the 420 lb. of combustible per ton, indicates that about 3,780,000 B.t.u. will be supplied by the material to be incinerated, leaving 1,638,000 B.t.u. to be supplied directly from an outside source, which in our case is through the use of fuel oil.

Upon the assumption that 1 gal. of fuel oil containing 150,000 B.t.u. will deliver about 110,000 B.t.u. for useful work in the process of incineration, it may readily be calculated that about 15 gal. of oil will be required to incinerate 1 ton of screenings, this calculation taking into account the difference between the total heat per gallon of oil and the total heat available for work per gallon of oil and representing the heat carried out in the gases at 1250° Fahrenheit.

It is estimated that about 600 gallons of oil will be required per 24-hour day to completely incinerate 40 tons of centrifuged screenings and grit, this quantity

Fig. 2—View of Incinerator Building, Showing Stack and Main Entrance to Charging Floor

of centrifuged material representing that contained in the anticipated sewage flow as of the year 1940, namely, 139 m.g.d.

With fuel oil costing 5 cents or slightly more per gallon, the total cost, based upon incineration at the rate of 40 tons per day, may be expected to vary somewhere between 75 cents and $1.00 per ton. Interest, depreciation, maintenance, and labor charges may be expected to add another dollar per ton, bringing the total cost chargeable to incineration to a point somewhere between $1.75 and $2.00 per ton. These figures, however, are to be viewed only in the light of and for the purpose for which they are stated herein, namely, that of affording an approximate idea only at this time relative to probable operating costs. A future article will deal with actual costs of operation when a time arrives at which the records can be considered to be truly representative.

The incinerator manufacturer has guaranteed the following performance of the equipment installed.

"These destructors are guaranteed to be capable of destroying, to a clean ash or clinker, not less than 20 tons in 24 hours of the sewage screenings and grit as specified.

"The destructors in full or partial operation shall not

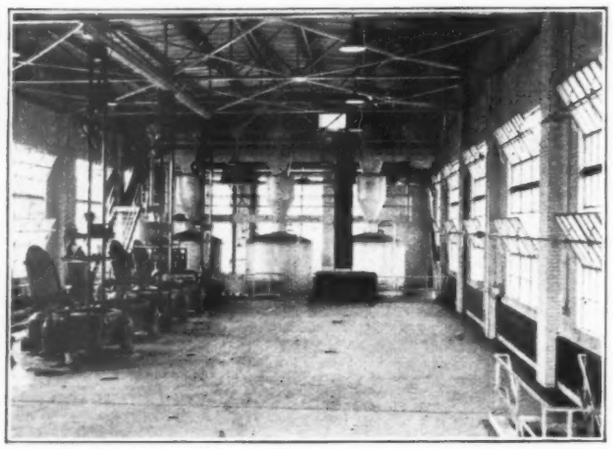

Fig. 3—Centrifuge and Ejector Floor. Ejector in Background

cause nuisance due to the escape of obnoxious odors or gases.

"All sewage screenings and similar combustible refuse charged into the destructors shall be dried and burned to a mineral ash containing not more than 1 per cent organic matter.

"The destructors are guaranteed against defect in material and workmanship for a period of one year.

"We hereby guarantee that there shall be no smoke during the operation escaping from the chimney of a degree of density greater than that determined by Chart No. 1 of Ringleman's Smoke Scale.

"We hereby agree and guarantee that the full requirements to dispose of the hourly capacity of each unit shall not exceed 12½ gallons of oil having an average fuel value of approximately 150,000 B.t.u. per gallon.

"Although not required by your specifications, we hereby guarantee that under normal and proper operation and operating conditions, no nuisance shall be derived from the presence of fly-ash or dust passing into the atmosphere from the chimney."

Description of Dehydration and Incinerator Plant and Its Operation

Figure 1 shows diagrammatically the arrangement and relative position of the equipment in the layout as a whole.

Briefly, the operation of this plant is about as follows:

Fine screenings are discharged from their present source of origin by the use of existing pneumatic ejectors through underground pipe some 500 ft. in length, and into one or the other of three 500 cu. ft. capacity pneumatic ejectors located within and at one end of the in-

Fig. 4—Charging Floor; Centrifugal Material in Piles

cinerator building. These ejectors were manufactured by Pneumatic Ejectors, Inc., Newark, N. J.

The grit is removed from the grit chambers, and hauled either in railroad flat cars, or by truck, and thereafter deposited by locomotive crane clam-shell bucket into draining bins located in the incinerator building at an elevation somewhat higher than that of the top of the ejectors, from which point it may be placed by manual labor into the top of one or the other of the 500 cu. ft. ejectors and there mixed with the fine screenings as they are received intermittently.

After an ejector has been filled, the flap gate at the top is closed, after which its contents are forced through a suitable pipe line by the application of sufficient air pressure within the ejector, to each of any one of the five specially designed centrifugal machines, as manufactured by the Tolhurst Company of Troy, N. Y. These

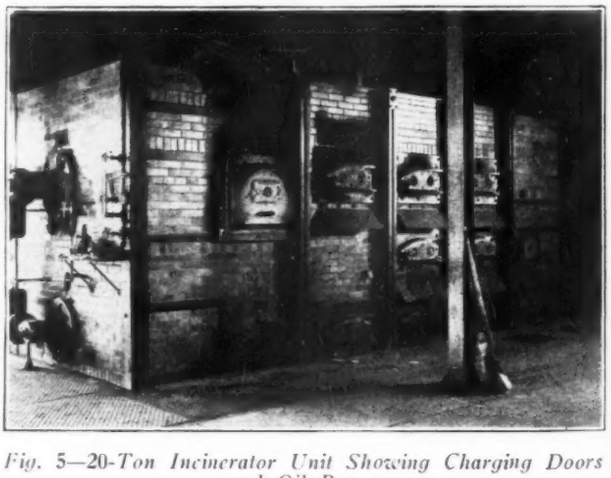

Fig. 5—20-Ton Incinerator Unit Showing Charging Doors and Oil Burner

machines are located on the centrifugal floor, which is on the same level as the charging floor above the incinerators.

The baskets of each of the centrifugal machines, which revolve at a speed of about 500 r.p.m., will hold 12 cu. ft. of wet screenings and grit. After the centrifuging cycle has been completed, the hinged cover of the unit

is raised, and the basket is removed from the machine by means of small electric jib cranes. The basket is swung outward, then inverted, its contents falling into a hand-propelled buggy of suitable size to hold two such charges. The contents of the buggies are deposited on the floor above the incinerator near the charging holes, from which place they are fed by hand into the incinerators.

The fuel oil tanks are located in a suitable pit, outside of the building, in which provisions are made for supplying heat during colder months of the year. Small oil pumps are used for pumping the oil from the tanks to the Anthony Nebulite burners, with which each incinerator unit is equipped.

The coarse screenings, which at the present time and for some years past have been centrifuged in the coarse screen building located at some little distance from the site of the incinerator building, will continue to be centrifuged in this location as at present, and will be hauled by truck at intervals of possibly two or three times a week, as the occasion requires, to the incinerator plant.

The two incinerators are served by a stack 100 ft. in height and 5 ft. in diameter, sufficient oversize having been allowed to accommodate a possible 40- to 50-ton future unit. The contract for erecting the stack was awarded to the Alphons Custodis Chimney Co., of Chicago.

The total cost of the installation complete ready to operate was $147,600.00 of which $70,500.00 is the cost of the building, stack, service tunnel, connecting sewer, and oil storage tanks. The balance ($77,100.00) covered the cost of all equipment and appurtenances installed, such as air, water, steam and screenings piping, electric wiring and lighting, and minor miscellaneous items.

In the article to follow at a later date the various phases of the operation of this plan will be discussed and comparisons cited between anticipated operation as visualized at the time of design, and that which has actually obtained during the time the plant has been operating.

The plant described in the foregoing was recommended, designed and constructed under the supervision of James L. Ferebee, Chief Engineer of the Sewerage Commission, and Mr. T. Chalkley Hatton, former Chief Engineer of the Commission, served in the capacity of Consultant.

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Experience in Sterilizing New Mains

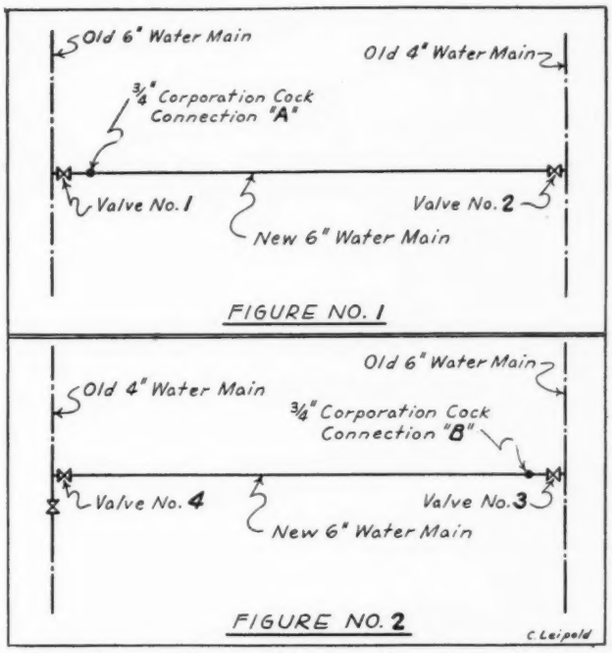
By Carl Leipold

Superintendent of Filtration, Winnetka, Ill.

PRODUCTION of a clean, safe and palatable water at the purification plant does not assure the same quality of water at the consumers' taps unless the distribution system is clean and free from contamination. The water department of Winnetka aims to prevent recontamination of the water supply from new pipe additions to the distribution system. This is effected through the application of "H T H" (calcium hypochlorite) and by proper flushings of the pipes.

It was shown by tests made at the time of sterilizing a new pipe line that it is very essential that the water added to the pipe will distribute the applied "H T H" uniformly through all parts of the new pipe.

On completion of a new pipe line (Fig. 1) about thirty grams (a heaping handful) of "H T H," representing a treatment of 100 lbs. chlorine per million gallons of water, was applied through a paper funnel placed in the neck of the corporation cock at connection "A" and the pipe was filled with water through valve No. 1. Residual chlorine tests made of the water samples collected from connection "A" after all the air was removed and the pipe was full of water, showed only .10 to .20 P.P.M. of free chlorine. After a chlorine contact period of 3 hours, valve No. 2 was opened and the new pipe line was flushed through connection "A." Residual chlorine tests made of the water samples collected from connection "A" showed a gradual increase of free chlorine and after 30 minutes of flushing the test showed a deep red color. These results indicated that on filling the pipe line, the largest portion of the disinfectant had been carried to the far end of the pipe line



Illustrating an Effective (Fig. 2) and an Ineffective (Fig. 1) Method of Sterilizing Water Mains

near valve No. 2, leaving no chlorine for sterilization at the near end of the pipe line where introduced.

On completion of another new pipe line (Fig. 2) the same sterilizing procedures were carried out as described above with the exception that a different method of filling the pipe line with water was employed. This pipe line was partially filled with water through valve No. 3 and then completely filled with water through valve No. 4. Flushing the pipe line through connection "B" from valve No. 4 was done until the residual chlorine test of the water sample showed a deep red color. It was then closed off. After a chlorine contact period of two hours, valve No. 4 was again opened and the new pipe line was flushed through connection "B." The residual chlorine tests made of the water samples collected from connection "B" showed a gradual decrease of free chlorine and after 30 minutes of flushing the test showed no free chlorine. These results indicated that the "H T H" had been uniformly mixed throughout the pipe line by proper control of the valves.

The sanitary analysis of the water sample collected after the 30-minute flushing period indicated the water to be safe for drinking purposes at the time the sample was collected. The compactness and simplicity of the Hellige Comparator supplied by the Wallace & Tiernan Co., used for making the residual chlorine tests, rendered it very satisfactory for making the free chlorine tests quickly and accurately out on the job.

MODERNIZATION IN CHLORINE HANDLING

By CARL LEIPOLD

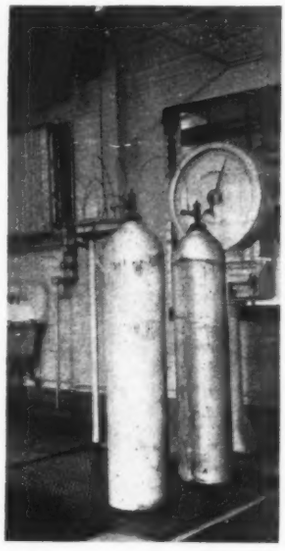
Superintendent of Filtration, Winnetka, Ill.

Improved Weighing Arrangements

THE portable type of beam-scale is fast disappearing from modernized water works plants. This old type with its platform about 8 inches above the floor line constitutes a health hazard because of liability of body strain, rupture, crushed feet or gassing of operators due to accident while handling cylinders of chlorine on and off the platform. If the platform be only sufficiently large for one cylinder, the chlorinator must be shut down every time a new cylinder of chlorine has to be connected up.

A modern dial type of scale having its platform set flush with the floor and of a size to accommodate two or more cylinders (1,100 lbs. minimum capacity), eliminates all of the evils of the old style scale. The net results are happier operators and the material reduction of health hazards. Chlorine cylinders can thereby be changed without shutdown of the chlorinator or discontinuity of chlorination. The accompanying pictures show the old and the new chlorine scale installations at the Winnetka Filtration Plant.

1927 — Two Portable Type Beam Scales, Accommodating 1 Tank Each, in Close Quarters —a Real Hazard.

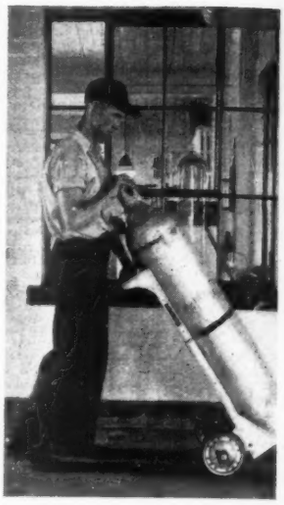


1933 — One Dial Scale Used for 4 Chlorine Cylinders. (Note the Safe Manifold Arrangement at the Center and Free Space.)

Transporting Cylinders

Transporting and handling chlorine cylinders (weighing 275 pounds when full) by rolling or lifting, creates added hazard and unnecessary work. Small trucks such as are used extensively in moving around cylinders of gas in hospitals are relatively inexpensive, take up little space and are easy to handle. The illustration shows the truck which we have used at the Winnetka Filtration Plant with great satisfaction. This particular one (Model 6352) was purchased from the Colson Company of Elyria, O. It has rubber tired wheels with ball bearings and a webbing strap snaps to one side of the truck to hold the cylinder in place—the rest is simple.

A 16-in. Propeller Exhaust Fan Located Near Floor Line in Chlorine Room.



Light Truck Used for Transporing Empty and Full Chlorine Cylinders.

Ventilation

In past years, we have had chlorine leaks which were a nuisance, if not actually detrimental to the operators' health, and also caused damage or tarnishing of the operating room equipment. There have been occasions, where the operators would cough, gasp and choke for air for a continuous period of 3 to 6 hours, and on other occasions, the men were unable to eat, drink water, smoke, or rest for 2 days. Chlorine leaks frequently occur when removing the empty tanks and replacing them with new tanks. Also chlorine escapes when changing the orifice tubes in the chlorinators, and at other times when work is necessary on the chlorinators.

The Sturtevant exhaust fan with a 16-inch propeller, outside automatic shutters and inside wire guard recently installed, has served the purpose of eliminating disturbances from chlorine leaks. The location of the fan, as shown in the picture, is near the floor because chlorine gas tends naturally to drop down.

The starting switch is located on the wall outside of the chlorinator room for the purpose of having it accessible without entering the room containing the gas and further for the protection of the switch also.

Making use of all modern ideas and improved equipment in chlorination schemes is justified on the grounds that property damage and accidents are thereby preventable or reduced to a minimum at least. The added cost is more than warranted as a measure of safety and by other advantages gained.

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Arthur H. Woods

It is with regret that we learn of the death of Arthur H. Woods, Superintendent of the El Paso, Texas, Water Works. Double pneumonia was responsible for his untimely death.

During his fourteen years as superintendent of the water works, he built, or completely re-built, every portion of it. Among other things he was an early advocate and user of copper service piping and fittings. He was widely known and admired in the Southwest as a fine man and highly capable water works superintendent. WATER WORKS AND SEWERAGE regrets the loss of one of its valued readers and contributors.

INTERESTING EXPERIENCES IN LOCATING PIPE LINES

By ROGER W. ESTY

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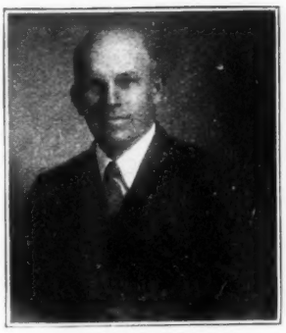

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"HEY! Mister, what cha' doing with that thing," spoke up a little tot about eight years old.

"Why, Sonny, I am trying to locate the pipe line that supplies you and your daddy with water."

"Well, how can you find it with that wire, why don't you use a shovel and dig for it?" chirped the youngster.

After explaining to the little fellow the best I could how his pipe line could be found, the boy watched every movement I made in locating the pipe and proved to be, as others are, a much bewildered spectator.

And so, when I first started to work in the water works profession, I too, felt bewildered, knowing that there was about one hundred miles of main pipe lines and service pipe in the ground, which some time I might be called upon to locate, shut off, turn on or repair.

No matter how carefully plans are made, showing in minute detail several measurements, which at the time taken seemed to be permanent markers or boundaries, these records soon change or are lost. Time soon erases many of these so-called permanent boundary markers. The house on the corner has been moved, the boundary changed from a right angle turn to a curve, the big elm tree has been cut down, and the catch basin moved, etc. What then? How are we going to find that main pipe line or that service corporation? That's just what I used to think about, myself.

But today, these days of miracles, we have the so-called wireless pipe locators. Most water works plants, I believe, have this wonderful device. To those who haven't one, and are not familiar with this device, this brief description of its mechanism and how it operates will make you marvel at its seemingly impossible accomplishments.

The Wireless Locator

The wireless locator is made up into two separate units which pack away very neatly and compactly into a small box about 12 x 10 x 8 inches. The whole outfit only weighs about 20 lbs. and can be very easily carried or moved around. (See Fig. 1.)

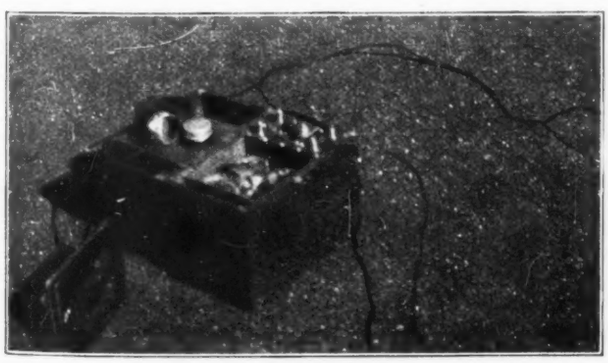

Fig. 1—The Wireless Pipe Locator Used in the Work Described in This Article

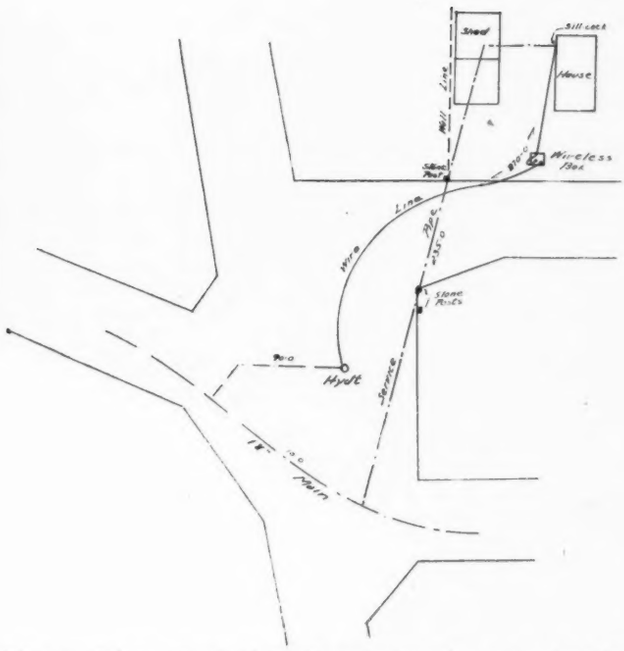

Plate 1—Scheme Successfully Used in Locating a Service Line Laid in 1876 Concerning Which There Was Absolutely No Record as to Location, etc. Note Its Passage Under the Two Stone Driveway Posts.

Within the box is a sending outfit made up of coils of wire and four dry cell batteries. On top of this apparatus is a vibrator or buzzer. This part of the apparatus is the sending mechanism.

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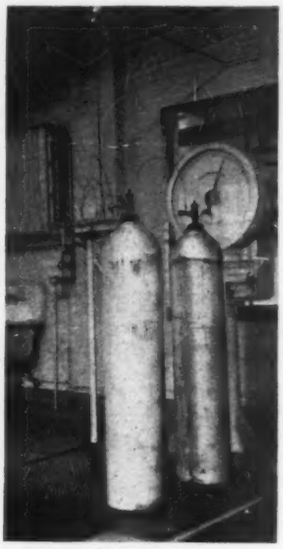

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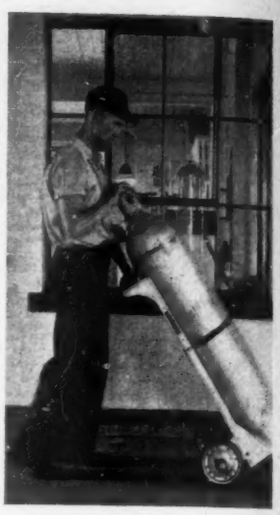

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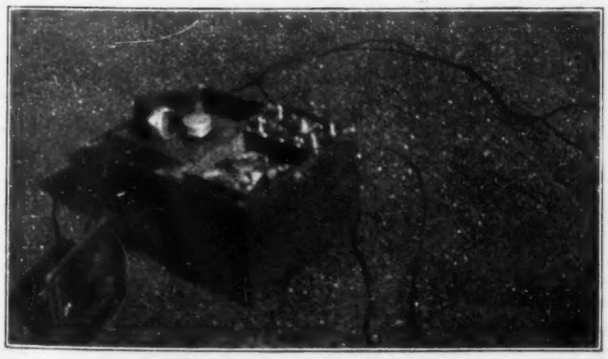

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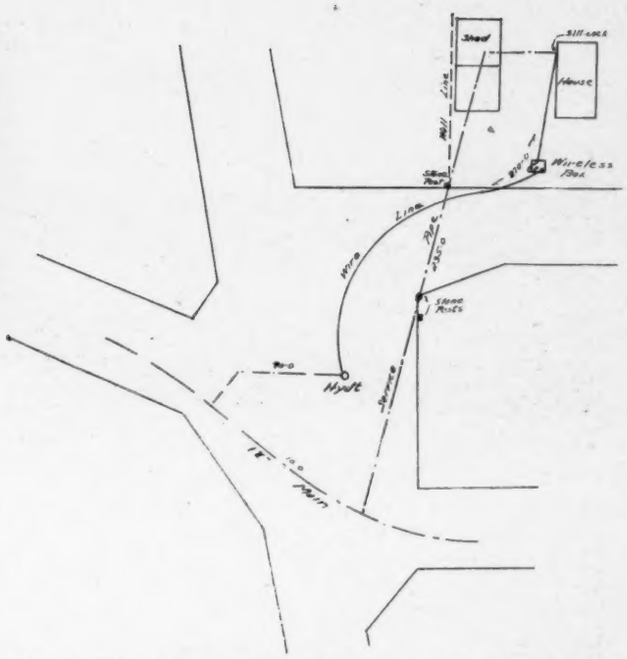

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Our first experience with this locator was in the next town on a service pipe line running across the square of the village center, thence across private property through another street to a house and barn, as shown on Plate 1. We had no knowledge as to where the corporation in the main was. The nearest guess as to where the connection was, by one of the natives of town, was not within fifty feet of where we actually found it.

The street pipe was an 18 inch main. We connected to a hydrant on the square and ran our wire over and connected onto the instrument that was set near the house. We then ran a wire from the machine to the sill-cock. We turned on the switch, picked up the receiving set and walked out over the wire for a short distance to make sure it was working. Remember this was our first attempt and this service had been laid since 1876, and nobody knew where it was. After finding that

the instrument was working properly; that is, a buzzing sound each side of the wire and no sound over the wire, we walked out into the "field." That is, the "field" is generally that section which is bounded by the wire lines and pipe lines to be located.

We walked over toward the hydrant branch which was about seventy feet long, and which we know the location of, in order to test it again. As we walked along, the buzzing continued until we started to walk over the pipe, then it stopped. I traced the hydrant branch along to the main pipe, turned and followed it

Fig. 2—Locating a Service Line Crossing a Road. Dotted Line Is the Main on the Other Side of the Roadway

along until I got a break in sound which seemed to be to the left of me.

I turned at right angles, picked up the break in the sound again and followed it along. I left the road as the pipe apparently passed under two large stone driveway posts, thence across the corner of the lawn, out into the street again and then across the street. It then followed under another stone post and wall, across the lawn under a shed and thence out into an open shed, turned at right angles and across the driveway to the house.

This work was done in the afternoon. We marked out the corporation location at the 18 in. main and left it until the next morning. We decided to disconnect it at the 18 in. main and make a new connection off the hydrant branch so as to take it out of the square.

We started two holes, one at the main to locate the corporation and another where we were to cut it off. We found the corporation right where we marked it off but did not locate the pipe.

The men called me up at noon time and stated that they were down six feet in a very hard material and had not found any pipe. I went up after dinner, connected up the machine again and jumped down into the hole with the receiver.

It only took an instant to pick up the break in sound again. I took a bar and sounded with it and I struck the pipe down about four inches. We were very much elated over the results, as it had actually located the pipe for us in the two places in which we wanted to find it.

Locating Pipe Sixteen Feet Deep

Several times we have traced out long lines, our longest being 4,400 feet of 18 in., 6 in., 2 in., 1¼ in. and 1 in. pipe. We have located pipe lines 16 feet deep. That 16-foot one I think is worth telling about, as the conditions were rather unusual.

At one of our large institutions, located at the highest elevation in Danvers, we have a 6,000,000 gallon reservoir. From this reservoir there are two pipe lines that can be used to supply this institution. The older of the two pipes was laid in 1876 and came out from the gate house, following along the side of the hill for a distance of about 1,200 feet. It then turned at right angles, crossing a roadway into the building. At this right angle it was down 16 feet. The other pipe line was off the line feeding into the reservoir and this ran along the side of the hill, making a sweeping turn into the same building and connected into the fire pump.

The officials at this institution were preparing plans for the erection of a new pumping station to house their service and fire pump, and they had to find the pipe at the right angle turn to make a connection. There was a bad leak in the line under the road which would be nearly impossible to locate due to the excessive depth. They felt that by connecting in at the bend, they could then come to the surface and lay a new pipe into the building about five feet below the surface.

We were asked if it were possible to locate the pipe. We knew then that it was a pretty tough assignment but said we would gladly try it for the experience we would gain by it.

We went up in the afternoon, looked over the ground for a possible connection for our wire line. We could not connect the two lines at the reservoirs, because they were on opposite sides, and it would require considerable wire to run down to where we could connect on to the pipe line.

Going along by the road, there was a high tension line that had been abandoned and was being taken down. We hit upon the idea of connecting into this line, as one of the wires had already been cut, and it was very easy to make a connection. At the other point where we wanted to make a connection we had to climb up a pole and to cut the wire, we connected this wire to our machine. We then ran our wire up the hill to the gate in the well house. At the other end, where we made the connection to this power line, we extended our line across the road through the building, to the gate at the well at the institution.

We made this connection during the afternoon and tried it out. The buzzing sound was very faint and there being just enough breeze to interfere with the ear phones, we decided to go up in the evening when it would be quieter, and thought possibly by this time the breeze would die down.

In a neighboring city they had practically a new machine and mine was six years old, I thought possibly the

Fig. 3—A Dog-Leg Service Line Successfully Located—Showing How It Is Possible to Locate Elbows and Sharp Turns in Service Lines

newer machine would work better, so I borrowed it for the occasion. I also took along four extra batteries.

As hoped for, that evening turned out to be very quiet, an ideal evening to work this machine. We made our connections and started out. The sound could be picked up faintly with the old machine. We changed it for the new machine and this proved still better. The sound was still rather weak and so we connected on four more batteries making eight in all. This gave us sufficient

volume so that we could trace it much easier. We went back and forth along the hillside and as we did this we staked out the pipe location.

At about this location they had a tunnel which went from the power house to the main plant. The floor of this was about ten beet below the surface.

We went into this tunnel and started down the stairway, and when we got to within about three stairs from the bottom the buzzing stopped. After a moment or two of testing we decided that the pipe was very close to the steps as the break in the sound was very sharp.

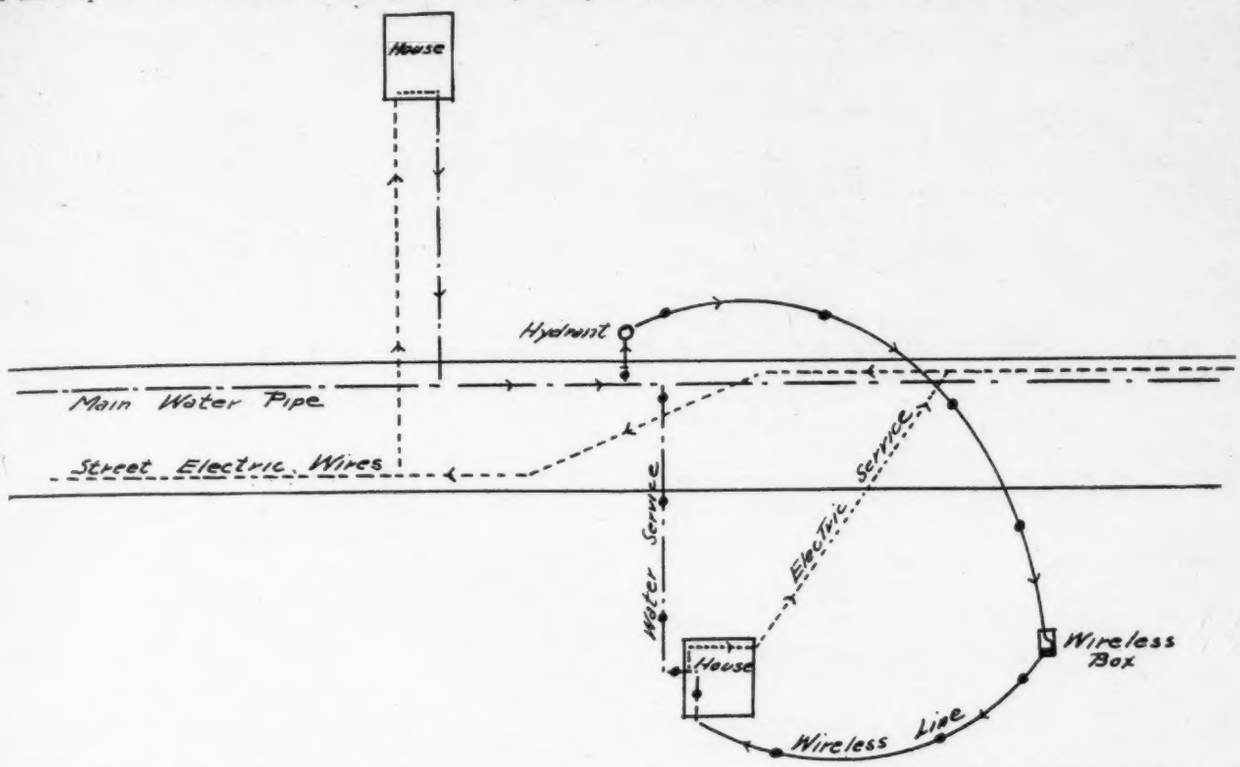

Plate 2—Illustrates the Effect of Grounding of Electric Wiring on Pipe Location Work. The Dotted Lines With Arrows Were the Only Ones Located Before Disconnecting the Grounded Wire. Afterwards the Service Pipe With Dots Could Be Easily Located and Was the Service Sought For

Later we found out from one of the workmen that he remembered some one saying that they had seen a pipe in the ground when they were preparing the ground for the tunnel foundation.

Further along side of the hill was a small building with a cellar under it. As this seemed to be about in line of the pipe we went into the cellar and there located where it was under the floor. By the sound of the machine we estimated that it was down about six feet.

We went outside again and tested along the side of the hill for the location of the elbow. This is always the most difficult part of the location work.

It is better to locate the pipe lines going away from the right angle turn and mark them out on the ground. You then draw back in a straight line across the right angle bend, and where the two lines intersect, will be the location of the bend. It always works out very nicely this way.

We drove in a stake on the side of this hill where we felt the elbow was from the intersection of the two lines. It is very interesting to note the width of space wherein there is no buzzing. In testing out the instrument directly over the wire line the break is very sharp. When the pipe is down five feet the break is six to twelve inches one way or the other. This one, sixteen feet deep, showed a break of about four feet.

They dug down sixteen feet into the ground and didn't find the pipe. I went up again, connected up the wire and climbed down the ladder into the hole. The instrument indicated it was at the edge of the hole under the sheathing. I sounded in under the plank sheathing and struck it with the bar.

It is needless to say how elated we were in finding this pipe. The officials at the institution were very profuse in expressing their appreciation, for it surely saved them a lot of money and time by being able to locate the pipe. It can be readily seen, that the time and money saved on this one job would more than pay for the machine.

Other Experiences

There are so many interesting experiences we have had with this machine that they canont all be enumerated here in this article. In using the finding device, I use a swinging motion similar to the movement of the pendulum of a clock. At the extreme ends of the swing a buzzing sound should be heard, and at half way mark of the swing there should not be any sound. Using the pendulum motion you can walk along quite rapidly over a pipe line.

I want to tell briefly an experience, illustrated in Plate 2, which we had only a week ago. We wanted to locate a pipe line going into a house in order to find the shut off box. We knew approximately the location of this pipe, but couldn't pick it up with the machine. In walking across the lawn with the locater it suddenly stopped. I knew that there wasn't any pipe there, so for a few moments I was baffled.

I tried it again and got the same results. Finally I noticed the electric light wire service into this house was over my head and that the machine was apparently operating under this wire line and not at the pipe line. I walked along under this wire to the street pole line, thence along the street to the house service, which was across the street, and up to the house and back over the service pipe line to the main pipe in the street.

I called in the superintendent of the electric depart-

ment to explain this apparent phenomena. He said that probably in one of the houses there was some faulty wiring causing the current to pass out through the ground wire and service pipe.

By disconnecting the electric ground wire we were then able to check out the water pipe line. Apparently sometimes the grounded wires will not affect the test, while at other times it will.

At the institution, I mentioned in the first part of this article, they tried to locate a six inch main going across a field. They dug a trench approximately a hundred and fifty feet long and in some places six feet deep. Fortunately in this case they used some fifty patients to dig this trench, so the cost of this work was only a minor factor to them.

I received a telephone call from them asking if I could help them again. I was glad of the opportunity to demonstrate the ability of this machine. It took about fifteen minutes to connect it up, as we had to run out about three hundred feet of wire, making a total circuit of pipe and wire of about nine hundred feet.

After turning on the machine it took only about two minutes to locate the trench, which happened to be about five feet beyond the end of their trench. We dug away about a foot of the earth and located the sides of the trench as it was very pronounced in the yellow and black loam.

I think this illustrates the foolishness of digging around blindly when pipes can be found within a half hour after the machine has been set up and the wire strung out. Going at a job in such a manner makes me think of the old saying, "All brawn and no brains."

Locator Saves Money and Time

We probably have used this machine a hundred times in locating service lines and main pipes. While we have found nearly all of them very easily, once in awhile you will run into some unusual condition. But, this makes it all the more interesting.

Two years ago, in a neighboring town, there was a dispute over a pipe line right of way. Nobody seemed to know where the pipe was or what rights they had, if any, across this private property.

There was a well supply at the foot of the hill, and the owner had put in a tank and an automatic electric pump. He ran a pipe line up across the fields and across the highways to several customers, the farthest being about 3,000 feet away.

A certain parcel of land was being sold and they wanted to designate on the ground and on a plan just where this pipe was located. They had no objections to it being there, but they wanted it located, surveyed, and recorded in the deed.

The surveyor called us in and asked if we could locate the first 1,000 feet. We told him we would gladly try our luck at it. Due to the distance between the houses and pumphouse and the changing of our set up, it took nearly the whole forenoon to locate and stake out the pipe line. Tho satisfy them as to our accuracy they requested that we should dig it out in one place before they would be convinced. We dug it out and found the pipe down about four and a half feet. This convinced them and so they staked out a right of way ten feet each side of our stake line, surveyed it and had the plan recorded with a description of the same at the Registry of Deeds.

A person using this machine continually would soon accustom himself to the various noises and sounds, and probably would not have any difficulty locating any pipe line. He probably would have many more interesting and unusual experiences than those I have told here. It can be used in locating both pipe and wire lines, inside or outside. It is light to handle and most any person can operate it. It does not require a person familiar with electricity to operate it. It operates on four dry cell batteries and is harmless. It is one of the most valuable machines I have, and if another could not be purchased, no amount of money could buy this one from me.

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Digest of Important Bill Passed by New York State Assembly

The New York legislature has just recently passed Introductory Bill No. 12 which is of considerable import to municipal authorities wishing to borrow from the NRA for public works betterment. A public emergency is declared to exist. All provisions of existing laws with certain exceptions which tend to prevent, hamper or delay public bodies from taking advantage of the provisions of the National Recovery Act are made inoperative. Public bodies are authorized to negotiate and contract with Federal government for loans and grants to construct public works projects and to receive and expend such moneys for such projects.

In case of projects paid for by direct assessment on real estate benefited, existing provisions for a permissive referendum remain in effect where the area of the benefit is less than that of the municipality. It is unnecessary for any board or public body to hold hearings on or publish notices of such projects or for projects to be initiated by petition of taxpayers or owners of property nor shall such project be subject to a referendum, mandatory or permissive except that this provision does not operate to dispense with a hearing under the general district law and the constitution on the sole question of whether a proposed improvement benefits all the property in a district liable to taxation for defraying all or a part of its cost.

Municipalities are authorized to sell their bonds to the Federal government without advertisement, proposals, or public or private bidding. With respect to federal loans, all existing laws requiring bonds or other obligations of the municipality to be serial or payable in annual installments or fixing the maximum or minimum times when the debt contracted shall be payable are made inoperative.

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Powdered Carbon Improves Coagulation

From Canada comes a report of the merits of powdered activated carbon as an improver of coagulation at the Ottawa Filtration Plant. Originally the use of "Nuchar," applied to the raw water, was intended for stabilization of the highly organic (and therefore putrescible) sludge accumulating in the basins during the warm weather period. It was discovered, however, that the formation of the alum floc was considerably improved and was not only better formed but settled out more rapidly. The report does not go into details concerning the dosages.

The observation is reported because this case confirms similar effects noted at other American plants—especially those handling comparatively clear waters which contain algae or other organic matter—at which the combination of powdered carbon and alum has resulted in improved or more economical coagulation. All of which brings to mind the new product—"Black Alum"—recently introduced as an improved coagulant. The latter consists of sulphate of alumina (filter alum) compounded with a small percentage of activated carbon. It is offered primarily as an aid to coagulation and a stabilizer of sludge and incidentally as a partial corrective for taste and odor trouble.

SEWAGE DISPOSAL AT SPARTANBURG, S. C.

By GEO. W. WHITE*

Engineer, The Harwood Beebe Co., Spartanburg, S. C.

THE city of Spartanburg S. C., and its environs comprise a population of 40,000. When treatment of sewage became necessary for the city, much adjacent territory was involved. To meet this condition the "Spartanburg Metropolitan District" was formed, including the city and adjacent territory, with a total area of 34 square miles.

Under authority of the Spartanburg Metropolitan Commission, two intercepters, totaling 18 miles in length, and two treatment plants were constructed. By law all duites and powers of the Metropolitan Commission have been transferred to the Commission of Public Works of the City of Spartanburg, who have for some years handled the city's water works department very efficiently. The water works superintendent became general superintendent of both water works and sewage disposal. He has a plant superintendent for water works and one for the disposal works.

The Fair Forest Creek Plant

Spartanburg is located on the ridge between two streams, which makes two systems of sewage collection and disposal necessary. On the west is Fairforest Creek, a rather small stream, with a minimum flow of three million gallons per day. Into this creek 1,300,000 gallons of sewage was being emptied daily. Under these conditions complete treatment was deemed necessary. Accordingly the plant was designed with coarse, bar screen, sedimentation, sludge digestion and secondary treatment. The secondary treatment decided on consists of trickling filters and final sedimentation. The plant was designed for a capacity of three m.g.d to allow for future increase, without being unreasonably oversized. The intercepter, however, was designed for what was considered the ultimate development of the area. The plant is mechanically operated throughout, the provision is made for the use of chlorine to delay septic action, control odors and for other purposes.

Screens

The screen chamber and equipment are housed in a small brick building having ample ventilation. The screen consists of iron bars with one inch clear openings. It is cleaned mechanically, the equipment being controlled automatically by two floats. The floats are arranged to put the machine in operation when the difference in water level above and below the rack reaches a predetermined amount. The amount of difference to cause operation may be changed by a simple adjustment of the float apparatus. The equipment may also be controlled manually.

Sedimentation Basins

The primary sedimentation basins are in duplicate (Fig. 1), this being decided on for the purpose of flexibility of operation and to allow shutting down one unit without by-passing the entire plant. The basins are designed for two hours retention at the rated capacity, with an average water depth of nine feet. They are square and are equipped with clarifier equipment of the revolving girder type, which concentrates the sludge in a sump around the center pier. From there it is pumped, several times a day, to the sludge digestion tanks.

Sludge Digesters

The digesters are in duplicate also (Fig. 2), with a combined capacity of two cubic feet per capita of tributary population. They are circular concrete tanks, with concrete roofs and covered with earth. Each has a gas collector and is equipped with stirring and scum breaking mechanism. Trusses span the tanks and carry the driving machinery, which is housed in wooden buildings on the trusses. Four sample pumps are provided for

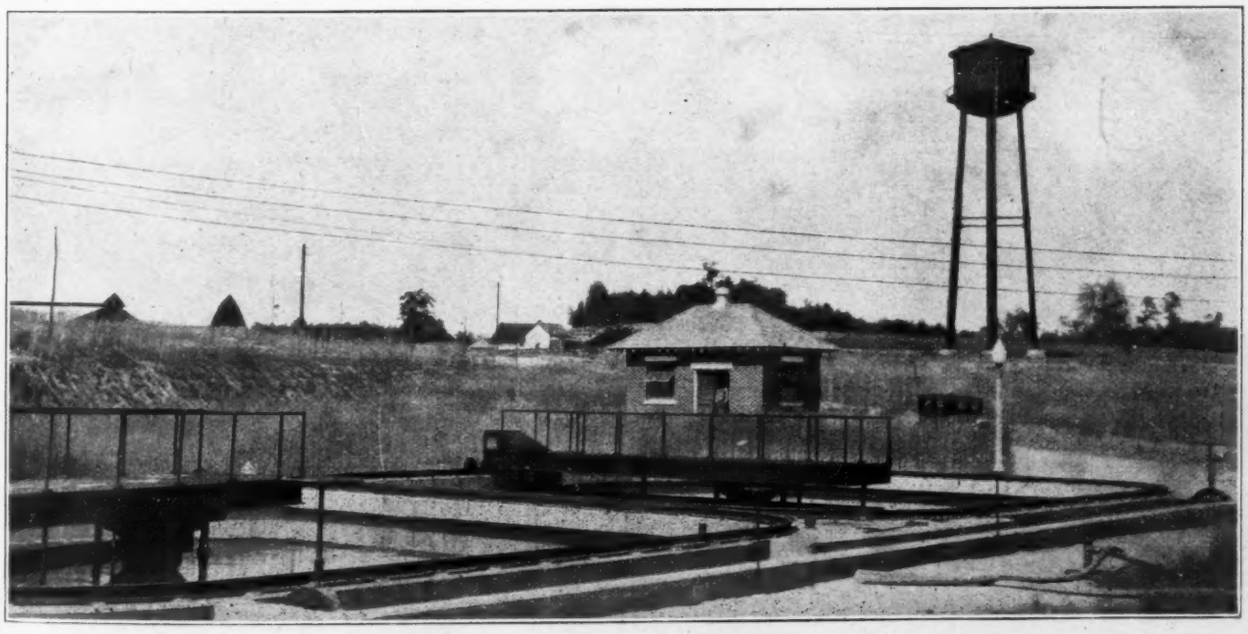

Fig. 1—Primary Clarifiers and Screen House, Fairforest Creek Plant

each tank. They are of the ordinary shallow well type, hand operated, and take suction from various depths. Sludge from the pumps is returned through a drain into the tanks. A water spigot and hose are located at each sampling point for cleaning up.

Approximately 17,500 cu. ft. of gas is being produced daily, or 0.7 cu. ft. per capita. The gas is used to heat the tanks and offices and for laboratory purposes. There is an excess above these needs that goes to waste but a use is being sought for this. Heating the tanks is accomplished by circulating hot water through pipe coils around the circumference of the tanks.

Fig. 2—Digestion Tanks and Operating House, Fairforest Creek Plant

Sprinkling Filters

The trickling filters have a stone area of 1.48 acres (Fig. 3) and are six feet deep at the upper side and 6.5 ft. at the lower. They are designed for 333,000 g.p.d. per acre-foot. Granite is used as filter medium. It is from 2 to 4 inch size for the lower seven inches of depth, and 1 to 2½ inch size for the remainder. This size is recommended by good authorities, but it was quite difficult to exclude all stone smaller than one inch.

An open inspection gallery (Fig. 4) extends along both sides of the filters for their entire length, with the distribution laterals and under-drains running across the beds. The laterals are carried beyond the last nozzle and through the inner wall of the lower gallery, where they are closed with screw plugs. The under-drains were carried through the inner wall of the upper as well as the lower gallery. These details provide means of cleaning out the laterals and drains, which have proved quite valuable. Each lateral is also provided with a gate valve in the upper gallery so that any section of the filter may be taken out of service when desired. The laterals were laid directly on the stone, without any other support, care being taken to bed them thoroughly. They were then covered with the remaining stone. No settlement has been noted.

The dosing tanks (Fig. 3) consist of two pairs of twin tanks equipped with 24 inch siphons and automatic feed devices. The available head was seven feet, and the design allowed a total loss of 1.75 ft. with a net head of 5.25 ft. on the nozzles. Each pair of tanks doses one-half of the bed.

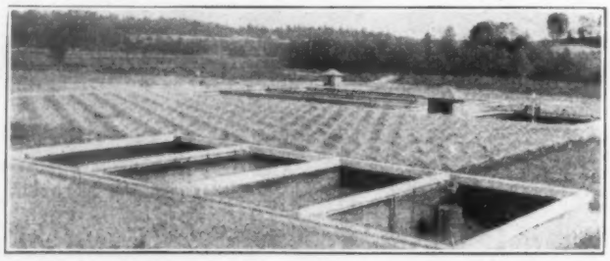

Fig. 3—Dosing Tanks, Part of Trickling Filters, Final Settling Basin and Sludge Drying Beds, Fairforest Creek Plant

The final sedimentation basin (Fig. 3) is a single unit and is similar to the primary basins. Its walls were carried up an additional three feet to protect the equipment from high water of the creek. A tide gate is used on its influent to protect the filter bed from floods. Sludge is pumped from this basin to the digesters by a pump located in a house adjacent to it.

Ample By-pass Facilities

Special attention was given to by-pass arrangements. The screen chamber has a weir by-pass above its entrance that will function automatically if the sewer runs full, and pass sewage around the screen. A sluice gate is provided to divert the sewage if it is desired to have access to the screen chamber. It also has a manually controlled by-pass that turns sewage directly into the creek. A by-pass is also provided at the effluent channel of the primary settling basins, and another at the lower side of the filters. Thus, sewage may be by-passed at any stage of its treatment.

Sludge Beds

Six sludge drying beds (Fig. 3) provide an area of 0.5 sq. ft. per capita of estimated population. They are open. Each bed is 20 ft. wide, with a drain down the center. They contain 6 to 10 inches of graded, crushed stone and 6 inches of sand. Sludge is admitted at points 40 feet apart on each bed. The elevation allows sludge to be drawn by gravity for about one-half the depth of the digestion tanks. If it is desired to empty the tanks below this point, it must be pumped.

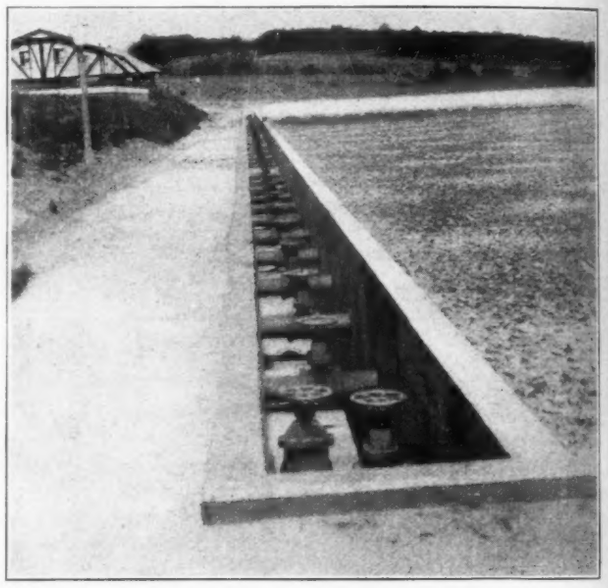

Fig. 4—Inspection Gallery of Trickling Filters, Fairforest Creek Plant

Chlorinating Arrangements

A Wallace & Tiernan vacuum type chlorinator is located in the screen house and is used to control odor and to delay septic action as the sewage passes through the clarifiers. Another is installed in a small brick house just ahead of the dosing tanks. A small amount of chlorine is used here for control of odor on the filters and to eliminate the filter fly. Occasional use for the latter purpose is quite effective. A third chlorinator is placed in a house at the junction of the final effluent and by-pass lines, for the purpose of sterilization when needed.

An operating house of brick (Fig. 2) contains the office, Venturi meter, laboratory, heating equipment for sludge tanks, primary sludge pump, and toilets. Elec-

tric power and light distribution panels, serving all the various units and lighting for the grounds, are also located here. This gives centralized control of the plant. The piping and valves for handling sludge are arranged so as to allow pumping of fresh sludge, circulation of sludge and transferring it from one tank to the other, at will. The sludge heating system consists of a gas burning boiler, a circulating pump and necessary piping and valves. It is equipped with recording thermometers on the out-going and return water lines.

Laboratory

The laboratory is fully equipped for conducting important tests for proper control of the plant and to determine the efficiency of the units. Regular analyses are made of composite samples collected at three hour intervals. The following table gives the average results that are being obtained.

Average Chemical Analyses at Fairforest Creek Plant

	Raw Sewage	Final Effluent	Fresh Sludge	Ripe Sludge
Sewage treated	1,300,000 g.p.d.			
Suspended solids	200 p.p.m.	20 p.p.m.		
Dissolved oxygen	neg.	4.5 p.p.m.		
B. O. D.	235 p.p.m.	31 p.p.m.		
pH	6.9		6.4	7.3
Moisture			96%	90%
Ash in solids			30%	60%
Gas produced (at 0.7 cu. ft./capita)			17,500 c.f. per day	

A deep well was drilled some little distance from the

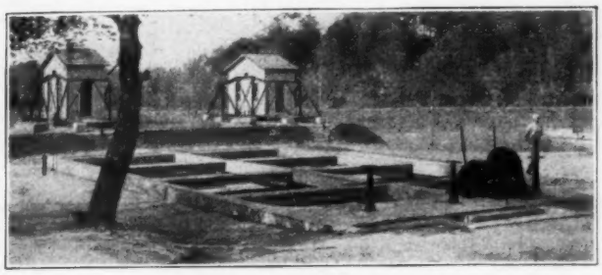

Fig. 5—Sedimentation Basins and Sludge Digesters, Lawsons Fork Plant

plant to furnish a supply of fresh water. A 50,000 gal. elevated steel tank was erected, and pipe lines laid to all parts of the plant. Water is used for cleaning and flushing and for general purposes about the office and laboratory. Blow-out connections were made to the various sludge lines where stoppage might occur. Hydrants for washing out the various units are located conveniently about the grounds.

Lawson's Fork Plant

The other plant is located on Lawsons Fork, a much larger stream than Fairforest Creek, and handles a smaller amount of sewage, 900,000 g.p.d. For this reason only primary sedimentation, chlorination and sludge digestion are provided. The plant is designed for 1.5 m.g.d. capacity, and is mechanically operated throughout as is the Fairforest Creek plant. The equipment, however, is somewhat different. (See Fig. 5.)

The screen cleaning mechanism operates with a drum and cables. It has a timing control that gives a fixed rest period of three seconds at the bottom and a period at the top that may be varied from three seconds to 33 minutes. It is usually operated at about eight or ten strokes per hour except when the sewage flow is light. It is then cut out altogether and operated manually at intervals of several hours.

The basins here are in duplicate also, but are rectangular in shape and are equipped with the endless chain type of mechanism. This draws the sludge to hoppers at the influent end of the basins. The hoppers are square, with steep sloping sides, tapering to a circular bottom so as to eliminate corners where sludge may accumulate and become septic. Skimming devices are also included. The skimmings being taken off at the effluent end of the tanks. These and the sludge are pumped to the digesters.

The sludge digestion tanks are similar in all respects to these at Fairforest Creek plant. A difficult construction problem was encountered, however. At about the footing level a deep bed of quick sand was encountered. This rendered a pile foundation necessary, and the floors were re-designed accordingly. The piles were placed in circles and their heads capped with concrete, poured monolithic with the floor. The floor slab spans from cap to cap. Piles 20 ft. long were used and most of them were driven to a penetration of 19 ft. without difficulty.

An operating house except for laboratory work serves the same purposes as that at the other plant. Such tests as are made on the operation of Lawsons Fork plant are made at the Fairforest Creek laboratory. Flood protection here required the construction of a dyke 12 feet high. A by-pass above the plant allows for diverting sewage at time of high water.

Association Meetings Scheduled

Sept. 5-7—**Pennsylvania Sewage Works Association.** State College, Pa. Secretary, L. D. Matter, Kirby Health Center, Wilkes-Barre, Pa.

Sept. 7-9—**Pennsylvania Water Operators' Association.** State College, Pa. Secretary, I. M. Glace, State Dept. of Health, Harrisburg, Pa.

Sept. 19-20—**Michigan Conference on Water Purification.** Grand Rapids, Mich. Secretary, John M. Hepler, State Dept. of Health, Lansing, Mich.

Sept. 19-22—**New England Water Works Association.** Hotel Stratfield, Bridgeport, Conn. Secretary, Frank J. Gifford, Community Water Service Company, Dedham, Mass.

Sept. 21-22—**Central States Section, American Water Works Association.** Hotel Pantlind, Grand Rapids, Mich. Secretary, B. J. Lechmer, City Water Commission, Erie, Pa.

Sept. 22-23—**Missouri Water and Sewerage Conference.** Ninth Annual Meeting, State Capitol, Jefferson City, Mo. Secretary, Herbert Bosch, Chief Engineer, State Dept. of Health, Jefferson City, Mo.

Sept. 25-27—**Wisconsin Section, American Water Works Association.** Hotel Schroeder, Milwaukee, Wis. Secretary-Treasurer, L. A. Smith, Superintendent Water Works, Madison, Wis.

Sept. 25-27—**American Society Municipal Engineers.** Milwaukee, Wis. Secretary, C. W. S. Sammelman, 4359 Lindell Blvd., St. Louis, Mo.

Oct. 7-9—**Conference of State Sanitary Engineers.** Hotel Claypool, Indianapolis, Ind. Secretary, R. E. Tarbett, U. S. Public Health Service, Washington, D. C.

Oct. 9-12—**American Public Health Association.** Indianapolis, Ind. Executive Secretary, Dr. Kendall Emerson, 450 Seventh Ave., New York City.

Oct. 12—**Central States Sewage Works Association.** Hotel Claypool, Indianapolis, Ind. Secretary, Gus. H. Radebaugh, % Sanitation District of Urbana, Ill.

Oct. 16-19—**Southwest Water Works Association.** Oklahoma City, Okla. Secretary, Lewis A. Quigley, Superintendent Water Department, Fort Worth, Texas.

Oct. 19-20—**Minnesota Section, American Water Works Association.** Hotel Curtis, Minneapolis, Minn. Secretary, R. M. Finch, 414 Flour Exchange Bldg., Minneapolis, Minn.

Oct. 20-24—**California Section, American Water Works Association.** Hotel Oakland, Oakland, Calif. Secretary, R. F. Brown, California Water Service Company, Stockton, Calif.

Oct. 24-26—**Rocky Mountain Section, American Water Works Association.** Denver, Colo. Secretary-Treasurer, Dana E. Kepner, 226 Continental Oil Bldg., Denver, Colo.

Oct. 26-28—**Missouri Valley Section, American Water Works Association.** St. Louis, Mo. Secretary, Prof. E. L. Waterman, University of Iowa, Iowa City, Iowa.

Oct. 27-28—**New York State Sewage Works Association.** Roger Smith Hotel, White Plains, N. Y. Secretary, A. S. Bedell, State Dept. of Health, Albany, N. Y.

Nov. 6-9—**North Carolina Section, American Water Works Association.** Hotel Vance, Statesville, N. C. Secretary, Prof. H. G. Baity, University of North Carolina, Chapel Hill, N. C.

ACCOUNTING FOR ANTHRACITE'S SUPERIORITY TO SAND AS A FILTER MEDIUM

By HOMER G. TURNER[1] and G. S. SCOTT[2]

LABORATORY experiments show that crushed anthracite possesses distinct advantages as a filter medium for water purification. In a previous paper[1] experimental data were given showing that fine anthracite is more efficient than Ottawa sand of the same screen mesh in the removal of turbidity. It is the purpose of this paper to inquire into the reasons for this superiority.

It might be well to begin our inquiry with a brief review of the origin of these two materials, for they have inherent differences which should not be overlooked.

Silica sand is the product of chemical and physical weathering of rocks containing quartz. This mineral, being vastly more resistant, both chemically and physically, than most of the associated minerals, has maintained its integrity through all weathering processes. The forces of transportation by wind or water have

A
Lump of Anthracite as It Appears Without Treatment.
X 2

B
Lump of Anthracite After Treatment to Show Micro-Structure. Dark Bands Are Former Wood and Light Bands Are Areas of Plant Debris.
X 2

Plate I

further purified this quartz by sorting and have at the same time rounded the grains. When the sand is finally deposited in its resting place it is composed of rounded grains of almost pure silica and hence is almost always exactly 2.65 in specific gravity.

Anthracite is the fossil remains of ancient swamps. The original tree trunks, branches, leaves and plant debris have been buried and changed by chemical and biochemical action into beds of highly carbonized organic matter. Pressure of overlying rocks and dynamic metamorphism, such as the folding of great thicknesses of strata, have further cemented this material and removed volatile matter, leaving a substance which is almost wholly carbon.

This final product is a hard, brilliant, black mass which breaks into angular fragments and which is apparently homogeneous in structure. When it is properly treated, however, and examined under the microscope, it is seen that the original plant entities have not lost their identity.[2] Tree trunks, leaves, spores, and other plant constituents are clearly visible although very much reduced in size and more or less altered in other respects. Plate 1 shows a piece of coal in its natural state and as it appears under the microscope after suitable treatment. The black bands in the treated specimen are woody branches or fragments of tree trunks and the lighter areas between are layers of plant debris.

These different constituents not only vary in composition but, what is more significant, they vary in specific gravity. From this it might be anticipated that the specific gravity from grain to grain would vary in filter coal prepared from a given bed of anthracite and that this difference would be still greater where several beds were crushed to provide coal for filter purposes. From a study of specific gravities of 200 "face" samples taken from all working beds over the whole anthracite region it has been found that there is an actual average specific gravity difference of 0.10 in the coals from the same mine. Specific gravities over the whole region averaged from 1.49 to 1.68 for the different mines.

The foregoing fundamental considerations have shown that filter sand is composed of rounded grains practically identical from grain to grain in composition, specific gravity, and shape; that filter anthracite is composed of angular grains differing from grain to grain in composition, specific gravity, and shape. Let us then, consider the significance of these differences before presenting experimental data.

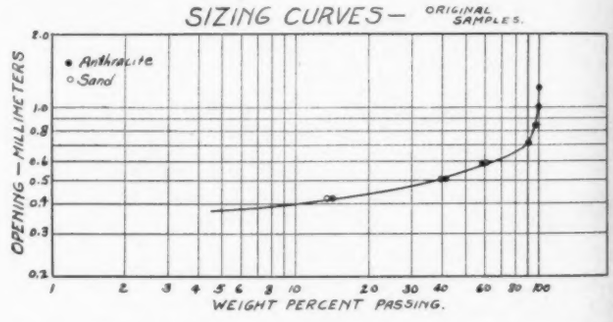

Fig. 1—Sieve Analyses of Sand and Anthracite Used in Experimental Filters.

A filter bed, after backwashing, is essentially a classified bed, with the finer particles concentrated near the top. Research in ore dressing has shown that classification is governed by the particle size, particle shape, and specific gravity difference between particles and the fluid medium in which they are suspended. When using water, as in filtration work, the density of the fluid is 1.0 for a "free settling" condition, such as would be the case if the filter bed were expanded several hundred per cent, and is somewhat greater than 1.0 when the expansion of the filter bed is such that the particles collide with each other. The latter condition is known as "hindered settling."

If we consider that silica sand has a practically constant specific gravity of 2.65, and a comparatively uni-

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[1]Homer G. Turner and G. S. Scott—"Clarification of Water by Filtration Through Anthracite"—WATER WORKS AND SEWERAGE, April, 1933.

[2]H. G. Turner, "Constitution and Nature of Pennsylvania Anthracite with Comparison to Bituminous Coal," Trans. A. I. M. E., February, 1930.

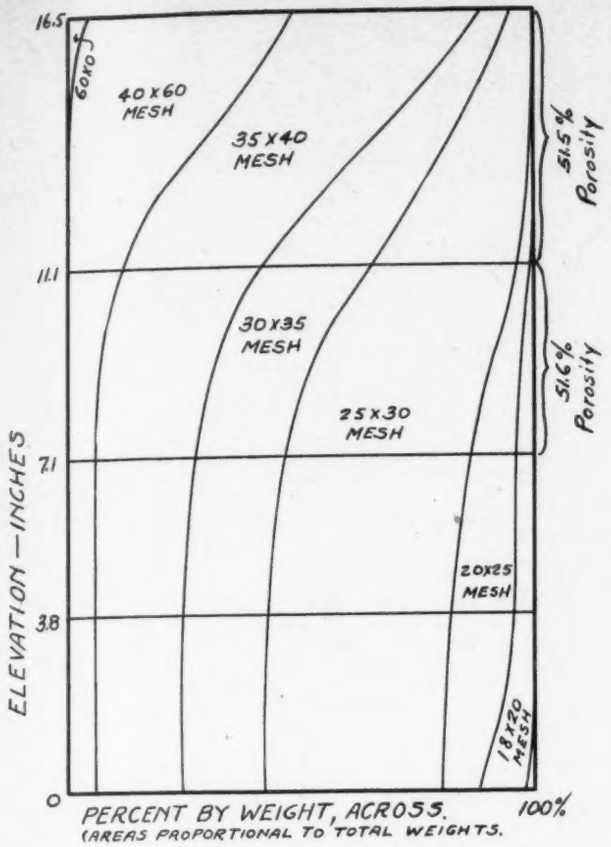


Fig. 2—Sieve Analysis of Anthracite Bed from Top to Bottom.

form particle shape, it would be expected that classification of a sand bed would be largely a classification according to size. Since anthracite is angular in shape, and since the specific gravity of individual particles in a given sample varies within certain limits, it would be expected that anthracite would be classified according to several factors, and, therefore, the size distribution in a given horizontal stratum, would be greater than that for sand.

Due to the much lower specific gravity of anthracite, a bed less compact than that of sand might be expected after backwashing. It would also be expected that the greater angularity of particle would tend to give a greater porosity for anthracite.

A pyrex tube 2 and 5/16th inches in diameter, with water connections at the bottom, was set up in a vertical position. A 3-inch stratum of lead shot (1.75 mm. diameter) was placed in the bottom of the tube to distribute the wash water uniformly. A sample of commercial filter sand was poured dry into the tube to give a bed 15.4 inches deep. This sample was then backwashed for 30 minutes at 50 per cent expansion of the bed and after settling the depth of bed was measured. The water was then drained off and the sand removed through the bottom of the tube in sections. Each section was dried, weighed, and sized. The results are shown in Fig. 3. A sample of fine anthracite was treated in a like manner. The results for anthracite are shown in Fig. 2. The sizes of sand and anthracite used in these experiments are shown in Fig. 1.

Actual measurements of the porosities of the two top sections in each filter are shown on the charts. The porosity of the coal near the top of the filter is 13 to 15 per cent greater than the porosity of the sand. These porosities were determined by the Hulbert method.[3]

Further examination of these charts shows the following points: (1) A greater size distribution near the top in the case of the coal filter. (2) The 30 × 35 mesh material in the case of sand tends to concentrate in the intermediate strata. (3) The 25 × 30 mesh sand tends to concentrate in the intermediate and bottom strata while the coal of this size is distributed more or less uniformly from top to bottom. (4) The 20 × 25 and 18 × 20 mesh sands are much more concentrated near the bottom than is the case with coal of the same sizes.

Anthracite, because of its lower specific gravity and its angular particle shape, offers a greater porosity than does sand. At the same time, due to its angular shape, it exposes more surface to the floc than does the rounded sand, since a spherical shape possesses the least surface per unit of volume of any solid.

Due to the variation in specific gravity and to the angular shape of particle, an anthracite filter bed is more uniform from top to bottom with respect to particle size distribution.

These properties combine to permit greater depth of floc penetration with consequent decrease of clogging near the surface and thus permits longer filter runs, with a given efficiency in the removal of suspended matter (turbidity) from the water.

Greater efficiency is obtained because of the larger area of grain surface exposed, and because the increase in particle size with depth is less marked with anthracite than is observed in the case of sand.

Acknowledgment.—The writers wish to acknowledge the coöperation of the Mineral Industries Experiment Station of the Pennsylvania State College.

[3]Robert Hulbert and Douglas Feben, "Hydraulics of Rapid Filter Sand," Proc. of Central States Section of American Water Works Asso., at Erie, Pa., September, 1932.

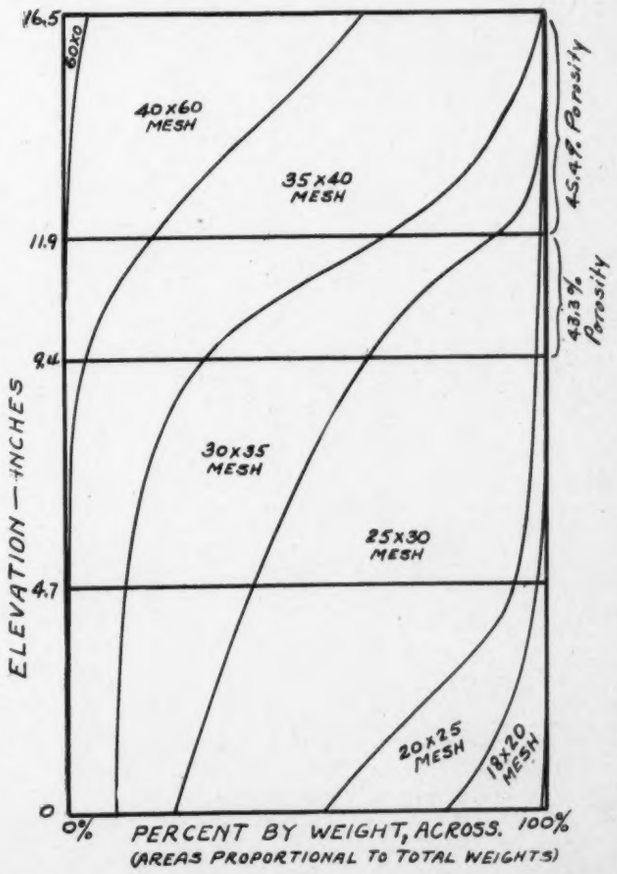


Fig. 3—Sieve Analysis of Sand Bed from Top to Bottom.

OBSTACLES ENCOUNTERED IN THE FLOW OF WATER THROUGH FILTER BEDS

By JOHN R. BAYLIS

FOR years it has been the desire of filtration engineers to devise better means of estimating filter performance. It is known that there are several factors which influence the length of the filter run—the more important of which are: (1) Size of sand—or to be more specific—the size of the openings through the sand. (2) Rate of flow. (3) Amount of suspended matter. (4) Toughness of the suspended matter. (5) Cracks which form in the surface of the filter bed. (6) Temperature of the water. (7) Depth of the sand bed. Attempt has not been made to list these factors in the order of their importance.

To obtain more information on filter performance, the Committee on Filtering Materials of the American Society of Civil Engineers has been sponsoring a series of tests on filter sands, varying widely in size and grading, at several water filtration plants throughout the country. This work, which is under the direction of Mr. James W. Armstrong, is now nearing completion. The sand for these experiments was sieved to certain sizes, and the beds were made up to cover fairly wide range in size and grading of the material. The same kind of material was used by all of the cities coöperating in the work, and any difference in filter performance should be due to the water or the manner in which the filters are being handled at the different plants. Efforts were made to have the operation at all plants as uniform as possible. The writer does not know what major conclusions will result from these experiments, but surely something of value will be determined.

In addition to this work, others have been studying certain phases of filter performance. Hulbert and Feben[1] have published the results of their very comprehensive investigation of the flow of clear water through clean sand; that is, the initial loss of head or friction through the sand bed. From this, they developed a formula for the flow of water through sand which is somewhat different from formulas developed by Hazen and others. It might be well to state that Hazen's formula[2] was for computing the flow of water through slow sand filter beds and that it gives very good results for such beds. It appears not to be quite so accurate as the recently developed formulas for the flow through rapid sand filter beds. The formula developed by Hulbert and Feben is as follows:

$$l = \frac{9.84\ Cp}{10^3}\left[\frac{d\,r}{S^{1.89}\,(t + 20.6)}\right]$$

l = loss of head in feet.
d = depth of sand in inches.
r = rate of flow in m.g.a.d.
Cp = coefficient of porosity.
S = sand size in mms. (50 per cent or median sieve size).
t = water temperature in degrees F.

This formula shows the effect of the size of the sand to vary inversely as the 1.89 power of the diameter.

Prof. Gordon Fair, at the June meeting of the American Water Works Association held in Chicago, gave results of investigations conducted under his directions on the flow of water through sand. The writer does not have a copy of the formula presented by Prof. Fair, but it differed somewhat from the one developed by Hulbert and Feben. Fair found that the loss of head varies inversely with the size of sand squared. There also was a difference in the porosity factor. There seems to be little doubt that Prof. Fair has given us a very useful formula which is applicable to all conditions where it is merely a matter of the flow of clean water through sand. Within the ranges of sand sizes used in rapid sand filters, the formula developed by Hulbert and Feben also appears to be very accurate.

The writer should like to commend very highly the excellent work of Hulbert and Feben, and that of Prof. Fair. The only justification of this article is that some have formed the opinion that it is only a matter of adding to these formulas certain other factors and we will have a formula for computing actual filter performance. It is not believed that the problem is so easy of solution and the reasons for this belief will be given. The formula by Prof. Fair, however, should be very useful in computing the flow of water through most any porous material.

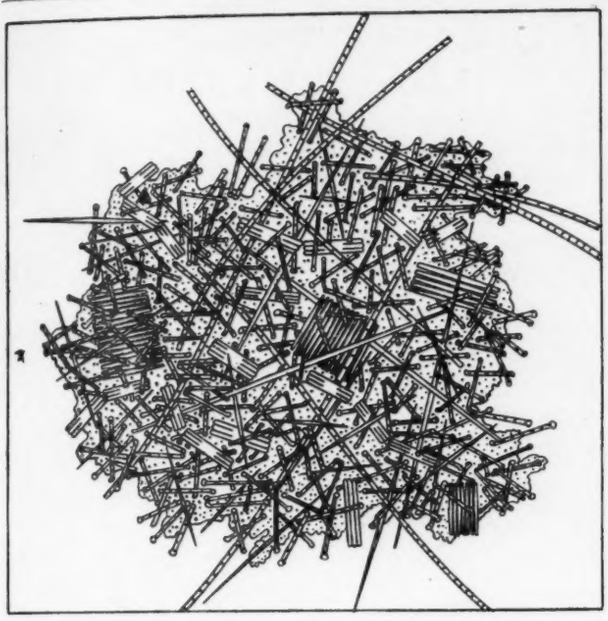
Character of the Suspended Matter.—One of the rapid sand filters (10 sq. ft. in surface area) in the Chicago Experimental Filtration Plant was operated four years on the raw Lake Michigan water without any treatment whatever. The time required for this filter to reach 8 feet loss of head varied from a maximum of 140 hours the latter part of January, 1930, to a minimum of 0.6 hour May 2, 1929. There were enough runs shorter than 1 hour and enough runs longer than 50 hours to demonstrate that it was no mere accident which caused these extremes. There were a number of runs of less than 3 hours when the turbidity of the raw water was 5 or less. The maximum run occurred with a turbidity averaging about 20. Except for turbidities above about 50, there was no relation between the turbidity and the length of the run.

In general, the results showed that the factors influencing the length of the run, other than the size of the opening through the bed, was limited almost entirely to the *character* of the suspended material, and *not amount* of suspended matter. The actual filter runs for a definite treatment and a definite period of sedimentation were so near a definite ratio to those on the control filter receiving the water without treatment, that the runs on the latter could be used as a basis for computing the filter runs which would be obtained in the plant.

With sand of a definite size, the major factor influencing the lengths of the filter runs is the character of the suspended matter originally in the water and the amount of this matter which reaches the filters. Perhaps something as to the clogging tendency of the water may be told from a microscopical examination of the water. In our experimental work the relation between the microorganisms in the water going to the filters and the filter runs seem close enough for approximate evaluation, but certainly not for accurate evaluation. The microscopical characteristics of the Lake Michigan water, however, may vary widely from other waters. In the very beginning of our study of filter performance we found this major factor impossible to estimate, except that we

could roughly approximate it by microscopical examination of the water.

At the present time there is no uniform procedure of making microscopical examinations and different laboratories will vary widely in the enumeration and measurement of the volume of the organisms. If there was uniform procedure in the microscopical examination of water which gave uniform counts and volume of the organisms, this still would not reduce their effect upon filter runs to mathematical exactness. The size and



COMPACT ALUMINUM HYDROXIDE COAGULATION CONTAINING MICROORGANISMS.

Fig. 1—Mat of Organisms Collected at the Surface of a Filter Bed

length of the individual organism or masses of organisms would have to be taken into consideration. Bryozoa or crustacea which produce only 4 or 5 cubical standard units per cc. may clog much worse than some of the other organisms which occur to the extent of 400 to 500 cubical standard units per cc. Filamentous organism of 10 to 20 volumes per cc. also may clog worse than several hundred volumes of some other organism.

Before there can be any progress in attempting to reduce the effect of the suspended matter on filter runs to mathematical computation, there must be material improvement in microscopical examinations. It is true that all waters are not affected so greatly by microörganisms as the Lake Michigan water, yet most waters now being filtered have filter runs which vary widely. Figure 1 shows a drawing of a mat of organisms collected at the surface of a filter bed. It should be evident that the long organisms are very much more effective in strengthening the coagulation than the same volume of certain spherical organisms. Any attempt to take the character of the suspended matter in water into consideration for filter performance must be accompanied by an improvement in microscopical tests which more accurately takes into consideration the shape of the organism. After all this is done, there is no assurance that we would be much nearer reducing filter performance to mathematical computation, for there are other factors which effect the results.

Periods of Weak Flocculation.—There are periods of weak flocculation which occur in many waters. This is greatly influenced by the character of the suspended matter, and to a certain extent, the temperature of the water, yet there appears to be an unknown factor. The writer found at Baltimore that there were periods in which the coagulated matter would pass through the sand beds before the loss of head reached the maximum. These periods always occurred in the winter months, but temperature alone was not the cause. Filters had to be washed on the basis of the clarity of the filtered water without considering the loss of head. Filters with about 0.4 mm. sand for the 10 per cent size, sometimes had to be washed by the time the loss of head had increased 18 to 20 inches over the initial loss.

Not many filter operators are aware of this condition, yet there is evidence that such conditions occur in a number of plants. This factor certainly will have to be taken into consideration in the study of filter performance. It vitally affects the design of the proposed filters for Chicago, and is the factor which determines the rate of filtration and size of sand which may be used. Our experiments have not indicated any definite cause, nor any method of predicting when such periods of weak coagulation will occur. It is not a condition occurring with one type of coagulant, but occurs with all coagulants suitable for water treatment. With the present lack of interest in the strength of the flocculation produced in water coagulation, it may be a number of years before this important factor is understood.

Manner in Which Filtration Takes Place.—A third and very important factor affecting the lengths of filter runs is the manner in which the water passes through the deposited suspended matter which is removed from the water. In an article in the January, 1930 issue of WATER WORKS AND SEWERAGE, the writer explained his views of what takes place at the surface of a filter bed. This opinion has been formed after many observations, both on filter beds and upon glass tube filters. The three illustrations in Figure 2 serve to indicate what happens. When the filtration is nearly all at the surface, a mat is formed which prevents any further penetration

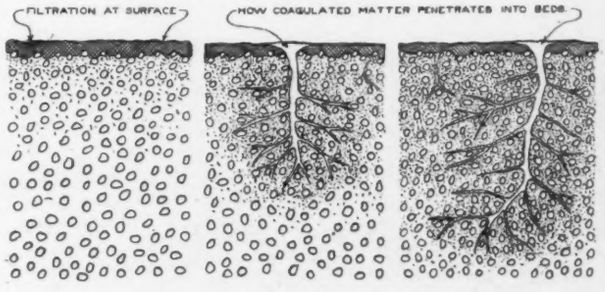


Fig. 2—Illustrating What Takes Place in a Filter Bed

of the suspended matter unto the filter bed, unless there are breaks through the mat. When the mat forms without breaks, the filter runs are short and are usually characterized by a gradual increase in the rate at which the loss of head increases. Filter runs under such conditions are usually too short for the practical operation of rapid sand filters.

What takes place most frequently in rapid sand filter beds is shown by the middle illustration and the one to the right in Figure 2. Apparently there are very few who have given much thought to how the coagulated matter penetrates into the sand beds. It seems to be the opinion of many that the coagulated matter which is first filtered out is gradually forced downward into the bed. This is not the case. Nearly all of the coagulated matter removed by filtration stays where it is deposited. Breaks occur through the surface at numerous points, dislodg-

ing some of the suspended matter in the path of the break, and carries it further downward, but this is a very small percentage of the total matter which has filtered out. By the time the filter is nearing the end of the run, most of the water is going into the bed through well defined holes or cracks through the surface. It does not seem possible that this effect upon the flow can be determined by computation. General assumption based upon empirical data may be made, and it is believed

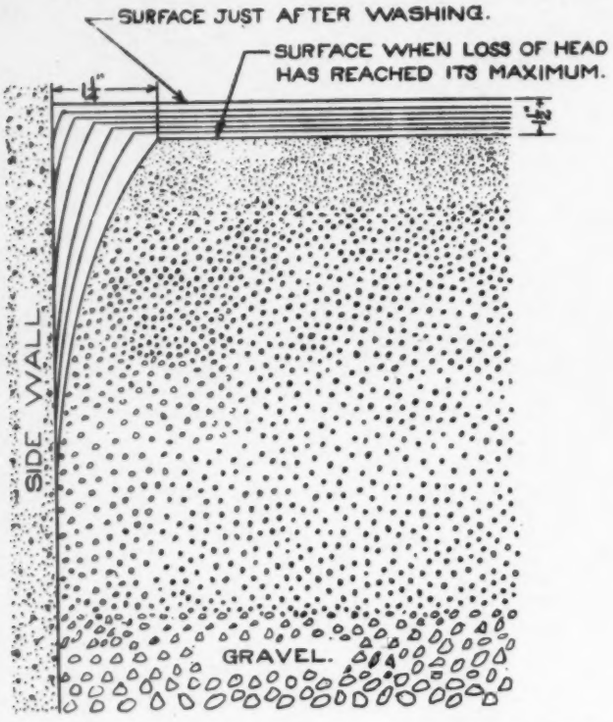


Fig. 3—Illustrating What Happens When a Filter Bed Pulls Away from the Walls

that this is about as close as one will be able to compute results.

Cracks in Filter Beds.—There probably is not a single filter bed throughout the country that has been in use for more than several months which does not have its filtering surface increased during the runs. Always there is at least a slight pulling away from the side walls of the filters in every rapid sand filter bed where the loss of head is allowed to run higher than about 5 to 6 feet. It may be as little as 1/16th inch in some beds and as much as an inch or more in others. This is not to say that the sand pulls away from the side walls all the way around the bed, but there is at least some pulling away in every bed. For fully three-fourths of the beds now in operation this pulling away is as much as one-quarter inch or more at certain seasons of the year.

The illustration in Fig. 3 shows approximately what happens as the bed pulls away. The writer made unusual efforts to prevent pulling away from the side walls in some of the filters at the Chicago Experimental Filtration Plant. A surface wash was installed and used regularly. The beds were kept unusually clean by use of this wash in addition to the regular wash. At first it was thought that we were going to be able to prevent sidewall cracks, but later it was found that there was a slight pulling away, which seldom exceeded ⅛ inch at the surface of the bed. This, however, was enough to effect the results. Our larger filters have 100 square feet of filtering surface and 40 linear feet of sidewall for each filter. Pulling away from the sidewall to a depth of 6 inches entirely around the bed is equivalent to increasing the filtering surface by 20 per cent.

A filter which has 1,400 square feet of filtering surface and is composed of 2 beds 14 feet wide and 50 feet long has 256 linear feet of sidewall. If the bed pulls away from the sidewall to a depth of 1.0 foot, nothing uncommon in some plants, the increase in filtering surface due to this pulling away is approximately 18 per cent. How can the effect of pulling away from the sidewalls, which occurs in all filter beds to a certain extent, be taken into consideration in a mathematical formula?

Not only do all filter beds pull away from the sidewalls, but cracks occur at times over the surface of the beds. It might be possible to prevent these cracks by use of a more effective washing system, such as the surface wash, but practically no one uses such a wash at the present time. Where surface cracks do not occur in the surface of the filter beds it is due more to the character of the water than to some unusually efficient washing

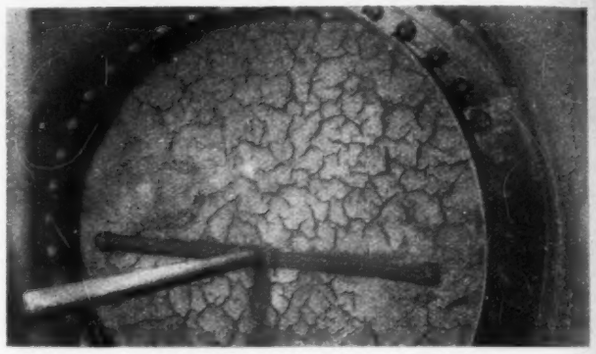


Fig. 4—Cracks in the Surface of a Filter Bed

system. The photograph in Figure 4 shows a condition in which the surface area of the filter bed has been increased more than 100 per cent over that of the normal surface of the filter bed.

The writer hopes these few remarks on some of the difficulties which will be encountered in attempting to reduce filter performance to mathematical computation will not be taken as criticising research work on the flow of water through sand. They are made to give some idea of the complexity of the problem. The writer is of the opinion that there are three major factors which so greatly overshadow other factors in filter performance that formulas for the flow of water through filter beds will be of minor value in computing filter performance unless they can accurately evaluate each of these factors. The factor of most importance is, of course, the size of the openings through the filtering material. The second major factor is the amount and characteristics of the suspended material such as size, shape, and strength of the suspended particles. This might be designated the clogging factor. The third factor is the extension of the filtering surface during the runs, and the formation of small holes through the surface layer.

The third factor may be improved or modified by using some washing system such as the surface wash, if any advantage would be gained by so doing. The first factor is capable of being expressed fairly accurately in a mathematical formula, but is not believed that there is any hope of reducing the second factor to mathematical computation. Such knowledge as may be gained will be largely empirical.

REFERENCES

[1]Hulbert, Robert, and Feben, Douglas. Hydraulics of Rapid Filter Sand. Jou. Am. Water Works Assoc., 25: 19-65, January, 1933.

[2]Hazen, Allen. Some Physical Properties of Sands and Gravels, Report, Mass. State Board of Health, page 541, 1892.

NOTES ON THE FERRIC CHLORIDE COAGULATION OF SEWAGE

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CHEMICAL precipitation is one of the original methods of sewage treatment, but has been largely replaced in recent years by biological processes. This change was due primarily to the cost of the chemicals and the quantity of sludge produced by the chemical process. Recent trends in sewage treatment are back to the use of chemicals, the objections having largely been removed by lower chemical costs and the development of mechanical sludge handling and filtration.

The author is of the opinion that more knowledge of coagulation as practiced in water treatment must be applied to sewage and that the trend of future developments will be along the line of coagulation rather than chemical precipitation. The distinction between the two processes is largely a matter of the quantities of chemicals used and the methods of application.

The object of coagulation in sewage treatment is the removal of finely divided suspended matter and a coagulation of the sewage colloids. Some knowledge of the nature of these colloids and their flocculation is essential to a successful application of this process. The following discussion is a brief presentation of the author's conception of colloid flocculation with especial reference to its application to sewage treatment.

Colloid Flocculation

When ferric chloride is added to water in the normal pH range, hydrolysis takes place resulting in formation of hydrates of ferric oxide, often wrongly termed ferric hydroxide. There are many of these hydrates, the one probably predominating in the concentrations used in water treatment is $Fe_2O_3\ H_2O$.

Whether or not the ferric oxide hydrate will flocculate or whether it remains as a colloid depends upon a number of factors. This colloid carries a positive charge in the acid pH range and a negative charge in the alkaline. The transition from positive to negative (the isoelectric point) comes in the range between pH 6.5 and 8.5.

The positive charge which is carried by the ferric oxide hydrate colloid is probably due in a great measure to absorbed hydrogen ion, because it has a high absorbing power for this ion. The intensity of this charge increases with the hydrogen ion concentration, i. e., lowering of the pH value.

Coagulation of the colloid can be accomplished by: 1, an adjustment of pH; 2, neutralization of the charge by the addition of a colloid of opposite charge; 3, neutralization of the charge by an ion of strongly opposite charge.

Water from different sources contains different types and quantities of colloidal material and varies in the kind and quantity of ions in solution. For this reason, each water will have its own optimum range for ferric oxide hydrate flocculation.

For instance, the tap water at Michigan State College will produce a good floc with ferric chloride in a ph range of 6.5 to 8.0, while no floc is formed below 6.5. On the other hand, a highly turbid river water used in certain flocculation studies gave excellent floc formation between pH 4.0 and 5.5, but no flocculation above 5.5.

This difference was due to the variation in colloidal material and ions in solution in each of the waters. The highly turbid river water contained a considerable quantity of negatively charged colloidal material which held up the flocculation of the two colloids until the intensity of the positive charge of the ferric oxide hydrate was equal to the negative charge on the turbidity colloid. As the pH was lowered, the intensity of the positive charge on the ferric oxide hydrate increased. At the same time, the negative colloid was approaching its isoelectric point and the intensity of the negative charge was decreasing. When the two were equal, flocculation occurred.

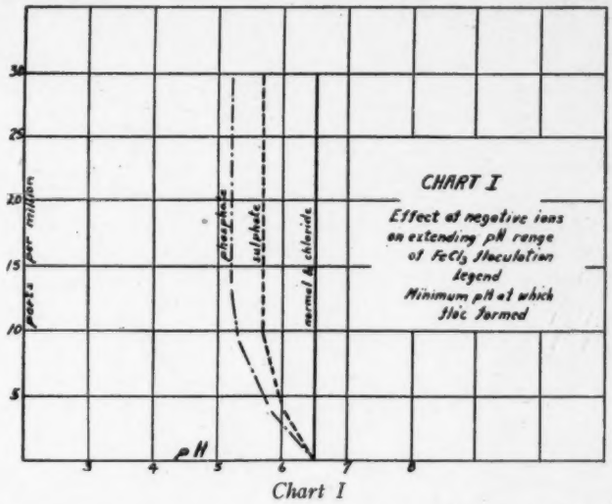

Chart I

Colloids have the power of absorbing ions and the electrical charge which is responsible for keeping them in the colloidal condition is greatly affected by the ions in solution in the water being treated. The effect of the addition of ions and the charges carried by them was shown in the case of the turbid river water. The highly positive manganese ion added in the form of manganic chloride caused a good floc to be found at a pH as high as 6.5. In other words the range over which flocculation occurred was extended from pH 5.5 to 6.5 by the addition of four valent manganese ions.

This same extension of the pH range by the addition of ions was shown in the case of the college tap water. Chart I shows how the range was extended by chloride, sulphate, and phosphate ions. In this case, since the ions added were negative, the range was extended toward the acid side. Positive ions extend the range toward the higher pH values while the negative ions extend it toward the lower values.

Those ions having the higher valence, either positive or negative, have the greater coagulating power. Thus, in order phosphate, sulphate, chloride; of the positive ions, manganese, chromium, calcium and sodium. The quantity of the ions necessary for coagulation depends upon the quantity of colloid present. Any amount beyond the quantity necessary to neutralize the charge on the colloid will obviously be of no added value.

Another agent to assist coagulation of ferric oxide hydrate in the presence of negative colloidal matter is the oxidizing agent, potassium permanganate. The effect of this agent is much more pronounced than that of any of the ions added. Quantities of potassium permanganate as low as two p.p.m. permitted the formation of the ferric oxide hydrate floc in the turbid river water at the normal pH range of the water, pH 7.8. This represented an extension of the range by more than two full units of pH value, i. e., from 5.5 to 7.8.

This effect can be attributed to the highly positive potential of the permanganate ion. Three of the seven positive charges of the manganese in the permanganate are extremely active and will account for the great neutralizizing effect on the negative colloids present in the water. If this is true, other oxidizing agents should have a similar effect. None of those tried, however, had anywhere near the activity of the permanganate. Chlorine was shown to have some beneficial effect as was potassium chromate. Neither of these, however, are as strongly positive as the permanganate.

The addition of ions and oxidizing agents in this manner will bring about the flocculation of ferric oxide hydrate at the normal pH range of the water being treated where otherwise the pH required might be so low as to necessitate a readjustment after clarification. As applied to sewage, however, a low pH value would not be as objectionable.

Sewage Coagulation

For the past few months an experimental plant has been in operation at the Engineering Experiment Station for the purpose of making a study of ferric chloride coagulation of sewage. Many interesting facts have been established. Among them it has been established that to obtain the maximum clarification effect from coagulation, a mixing and flocculation period of about ten minutes is essential. In applying ferric chloride at existing sewage treatment plants unless flocculating facilities are provided much, if not most, of the effect of the chemical is lost.

Regulating conditions in sewage coagulation must be similar to that practiced in water treatment, but will always be somewhat more difficult because of the rapidly varying conditions. In the experimental plant, good floc formation was sometimes obtained at the normal pH of the sewage which was between 7.0 and 7.5. This was the case when the sewage was thin or weak. As its colloidal content increased, the floc became lighter in weight and did not settle well. Under these conditions an adjustment of pH usually produced a better floc. Much better floc formation was obtained at these times by the addition of a small amount of potassium permanganate without a change in pH. The beneficial effect of the permanganate ion on the flocculation of this particular sewage was clearly evident.

As is the case in water treatment, the quantity of coagulant required bore a direct relationship to the character of the sewage at any particular time. Quantities of from 10 to 30 p.pm. of ferric chloride were used. Twenty p.p.m. usually gave a good floc and fair clarification. When the colloidal matter was high, the addition of from 5 to 7 p.p.m. potassium permanganate along with the 20 p.p.m. ferric chloride always produced an excellent floc.

The suspended solids in the crude sewage varied between 200 and 350 p.p.m. By regulating the coagulation to conform with the sewage, the suspended solids could invariably be reduced to between 18 to 25 p.p.m. Settling without treatment reduced the suspended solids to between 70 and 110 p.p.m.

The results from the experimental plant operation show quite conclusively that ferric chloride coagulation, *properly applied,* is a valuable adjunct to settling in sewage treatment.

Proper conditions and effective equipment for floc formation and coagulation, however, appear to be essential to the success of the process.

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Special Evening Courses in Sanitary Engineering

New York University announces that during the Fall and Winter of 1933-34 evening courses in Sanitary Engineering are to be given in conjunction with its Graduate School of Engineering. These courses have been especially designed to prove useful to practicing engineers who may take them without interfering with their normal business activities.

Thorndike Saville, Professor of Hydraulic and Sanitary Engineering in the newly established School of Sanitary Engineering, has arranged for the Evening Engineering Division, which if successful the first year, will become an established part of the Graduate School. This constitutes the first attempt of its kind in the metropolitan region of New York City and should prove of material value in offering engineers now engaged in Public Health Engineering and Consulting Sanitary Engineers, generally, an opportunity to keep abreast of developments and advances in the fields of Water Supply, Sewage Disposal, and General Sanitation.

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Traveling Power Hammer

The Keystone Driller Company of Beaver Falls, Pa., has recently brought out a new attachment which appears to have a broad scope of usefulness in connection with their steam shovels. As the picture indicates, the attachment when fastened to the boom of a revolving

Keystone Traveling Hammer

shovel serves as a powerful demolition hammer, weighing 3,000 pounds and capable of delivering 20 blows in one minute. This represents the fourth of the Keystone shovel attachments which are available to make their revolving shovels useful for a variety of applications.

DIGEST* OF CIRCULARS NO. 1 AND NO. 2 ISSUED BY FEDERAL EMERGENCY ADMINISTRATION OF PUBLIC WORKS, JULY 31 AND AUG. 1, 1933

Circular No. 1

The purposes, policies, functioning, and organization of the Federal Emergency Administration of Public Works are explained. In addition the detailed rules and regulations prescribed by the President are given. These rules control all contracts let and all loans and grants made pursuant to Title II of the N. R. A. Municipalities preparing applications for Federal aid for construction of water supply and sewerage improvements should study Circular No. 1 carefully. Outstanding excerpts from the circular follow:

"The President and the Emergency Administration . . . will aid in the construction and financing of any public works project deemed worthy of inclusion."

"No grant shall be in excess of 30% of the cost of labor and materials . . . in deciding to extend any aid or grant to a municipality . . . the President may consider whether action is in process or in good faith assured therein, reasonably designed to bring the ordinary current expenditures thereof within the prudently estimated revenues thereof."

"He (the President) may extend the benefits . . . to public bodies notwithstanding limitations on their power to borrow."

"The President has power to acquire any . . . property in connection with any projects approved by him to construct or finance the construction thereof and to lease such projects with or without privilege of purchase."

"The administrator, the state advisory board and the state engineer (P. W. A.) will apply the following tests in determining the eligibility of each project submitted:

(1) The relation of . . . the project to co-ordinated planning and its social desirability.

(2) Economic desirability . . . that is, its relation to unemployment and revival of industry.

(3) The soundness of the project from an engineering and technical standpoint.

(4) The financial ability of the applicant to complete the work and to reasonably secure any loans made by the U. S.

(5) The legal enforceability of the securities to be purchased by the U. S. or of any lease to be entered into between the applicant and the U. S."

"Projects integrated with and consistent with a state plan are to be preferred . . . projects which can be started promptly are to be preferred . . . projects near centers of unemployment are to be preferred."

"The following classes of projects will be preferred as to the grant:

(1) Water works projects not unduly burdening the community with debt and necessary for its health and convenience.

(2) Sewer projects of the same character.

(3) Sewage disposal projects sufficiently comprehensive to render a river or lake system, used by many communities, safe as a water supply, and other sewage disposal projects."

The grant will not be allowed unless the public body either (a) has power to sell to the U. S. its bonds in sufficient amount to reimburse the U. S. for its outlay (less the grant if allowed) . . . and enters into a contract so to do and to complete the project or (b) has power to convey the site of the project to the U. S. and contracts so to do, and to pay rental sufficient to reimburse the U. S. for its outlay less the grant if allowed, and to complete the project, or (c) or is in process of securing the necessary powers. . . ."

"The U. S. will bid par and accrued interest, for bonds to finance projects . . . provided all bonds bear interest at the rate of 4% or more. In the event such bonds bear interest at the rate of more than 4% the difference between 4% and the coupon rate will be refunded by the U. S. from time to time during the period while such bonds remain in the possession of the U. S."

"Bonds and obligations under contract of least are to be annually amortized pursuant to state statutes and according to the life of the project not to exceed 30 years except in the case of such projects as obviously have a longer life and in no case to exceed 50 years."

"When the applicant shall have furnished information and evidence . . . and the project has been approved . . . a contract will be drawn embodying such approved terms and if agreed to will be executed by the administrator and the applicant. The contract will state all the terms, including the wage and labor conditions, and will provide for supervision by the Administrator. . . ."

"The immediate program shall include only such projects as can (1) be started in 30 days, (2) are safe and sufficient from an engineering standpoint, (3) are necessary and convenient from a social standpoint, (4) the applicant has a balanced budget or is in process of balancing it."

"To the extent such projects are before it, the board and state engineer (P. W. A.) will give priority in the following order: (1) Waterworks and sewerage projects, (2) sewage disposal projects sufficiently comprehensive to render river or lake systems safe as water supply for large masses of population, and other sewage disposal projects, (3) other regenerative projects."

TABLE I—Showing spread of costs between Federal and local governments. $100,000 project; serial bonds; 30 year life; interest 4%; cost estimated, Federal $25,000; local $75,000.

End of Year	Annual cost			Paid by local government		
	Principal	Interest	Total	Principal	Interest	Total
1	$ 3,300	$ 4,000	$ 7,300	$	$	$ .....
2	3,300	3,868	7,168	.....	.....	.....
3	3,400	3,736	7,136	.....	.....	.....
4	3,300	3,600	6,900	.....	3,504	3,504
5	3,300	3,468	6,768	3,300	3,468	6,768
6	3,400	3,336	6,736	3,400	3,336	6,736
7	3,300	3,200	6,500	3,300	3,200	6,500
8	3,300	3,068	6,368	3,300	3,068	6,368
9	3,400	2,936	6,336	3,400	2,936	6,136
10	3,300	2,800	6,100	3,300	2,800	6,100
11	3,300	2,668	5,968	3,300	2,668	5,968
12	3,400	2,536	5,936	3,400	2,536	5,936
13	3,300	2,400	5,700	3,300	2,400	5,700
14	3,300	2,268	5,568	3,300	2,268	5,568
15	3,400	2,136	5,536	3,400	2,136	5,536
16	3,300	2,000	5,300	3,300	2,000	5,300
17	3,300	1,868	5,168	3,300	1,868	5,168
18	3,400	1,736	5,136	3,400	1,736	5,136
19	3,300	1,600	4,900	3,300	1,600	4,900
20	3,300	1,468	4,768	3,300	1,468	4,768
21	3,400	1,336	4,736	3,400	1,336	4,736
22	3,300	1,200	4,500	3,300	1,200	4,500
23	3,300	1,068	4,368	3,300	1,068	4,368
24	3,400	936	4,336	3,400	936	4,336
25	3,300	800	4,100	3,300	800	4,100
26	3,300	668	3,968	3,300	668	3,968
27	3,400	536	3,936	3,400	536	3,936
28	3,300	400	3,700	3,300	400	3,700
29	3,300	268	3,568	3,300	268	3,568
30	3,400	136	3,536	3,400	136	3,536
Total	$100,000	$62,040	$162,040	$86,700	$50,340	$137,040

Year	Paid by Federal government		
	Principal	Interest	Total
1	$ 3,300	$ 4,000	$ 7,300
2	3,300	3,868	7,168
3	3,400	3,736	7,136
4	3,300	96	3,396
5	.....	.....	.....
6	.....	.....	.....
7	.....	.....	.....
8	.....	.....	.....
9	.....	.....	.....
10	.....	.....	.....
11	.....	.....	.....
12	.....	.....	.....
13	.....	.....	.....
14	.....	.....	.....
15	.....	.....	.....
16	.....	.....	.....
17	.....	.....	.....
18	.....	.....	.....
19	.....	.....	.....
20	.....	.....	.....
21	.....	.....	.....
22	.....	.....	.....
23	.....	.....	.....
24	.....	.....	.....
25	.....	.....	.....
26	.....	.....	.....
27	.....	.....	.....
28	.....	.....	.....
29	.....	.....	.....
30	.....	.....	.....
Total	$13,300	$11,700	$25,000
Average annual cost			$4,568

*Prepared by the Division of Sanitation of the State Department of Health of New York.

TABLE II—Showing spread of costs between Federal and local governments. $100,000 project; city issues $75,000 bonds; serial bonds; 30 year life; interest 4%; principal deferred for 5 years; cost, estimated, Federal $25,000; local $75,000.

End of Year	Annual cost			Paid by local government		
	Principal	Interest	Total	Principal	Interest	Total
1	$	$ 3,000	$ 3,000	$	$ 3,000	$ 3,000
2	.....	3,000	3,000	.....	3,000	3,000
3	.....	3,000	3,000	.....	3,000	3,000
4	.....	3,000	3,000	.....	3,000	3,000
5	.....	3,000	3,000	.....	3,000	3,000
6	3,000	3,000	6,000	3,000	3,000	6,000
7	3,000	2,880	5,880	3,000	2,880	5,880
8	3,000	2,760	5,760	3,000	2,760	5,760
9	3,000	2,640	5,640	3,000	2,640	5,640
10	3,000	2,520	5,520	3,000	2,520	5,520
11	3,000	2,400	5,400	3,000	2,400	5,400
12	3,000	2,280	5,280	3,000	2,280	5,280
13	3,000	2,160	5,160	3,000	2,160	5,160
14	3,000	2,040	5,040	3,000	2,040	5,040
15	3,000	1,920	4,920	3,000	1,920	4,920
16	3,000	1,800	4,800	3,000	1,800	4,800
17	3,000	1,680	4,680	3,000	1,680	4,680
18	3,000	1,560	4,560	3,000	1,560	4,560
19	3,000	1,440	4,440	3,000	1,440	4,440
20	3,000	1,320	4,320	3,000	1,320	4,320
21	3,000	1,200	4,200	3,000	1,200	4,200
22	3,000	1,080	4,080	3,000	1,080	4,080
23	3,000	960	3,960	3,000	960	3,960
24	3,000	840	3,840	3,000	840	3,840
25	3,000	720	3,720	3,000	720	3,720
26	3,000	600	3,600	3,000	600	3,600
27	3,000	480	3,480	3,000	480	3,480
28	3,000	360	3,360	3,000	360	3,360
29	3,000	240	3,240	3,000	240	3,240
30	3,000	120	3,120	3,000	120	3,120
Total	$75,000	$54,000	$129,000	$75,000	$54,000	$129,000

Average annual cost $4,300

August 14, 1933.

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"A project of a public body approved by the administrator will be financed on the basis either (a) purchase of the bonds or other obligations of the public body issued to finance the project, or (b) lease, in that event the U. S. acquiring and holding title to the property until paid for its outlay (less the grant, if made) through rental or payment of purchase price."

"Public bodies will decide whether the issue of bonds be for the amount of the entire cost of the project . . . or such amount less the Federal grant if made. In the former case the grant may be utilized to meet the debt service for the early years, possibly 4 or 5, of the life of the bond issue. The effect of this plan of financing is shown in Table I for a $100,000 project, life 30 years."

"In case the public body decides to issue its bonds for only a portion of the total cost (total less grant) the cost of retiring its issue will be borne by it. The effect of this plan is shown in Table II for a $100,000 project, life 30 years."

"The applicant may if it considers the leasing provisions of the act most convenient make its application accordingly."

"Further, when the municipality has not the requisite borrowing authority it is also contemplated that the Federal government may finance the cost of the approved project and enter into a contract with the public body, if it has legal authority so to do, whereby the latter agrees to purchase such project on the installment plan through a period of years."

Circular No. 2

Gives the detail information required with applications for loans to municipalities and public bodies. Municipalities filing applications should carefully study Circular No. 2 to be certain that the data and information given correspond to that required.

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Connecticut Requirements for Operators of Sewage Treatment Plants

The General Assembly of Connecticut at its last session passed a bill providing that "The qualifications of the operators of sewage treatment plants shall be subject to the approval of the State Department of Health." Carrying out the intent of this statute, the Public Health Council of the State Department of Health, of which Warren J. Scott is Director of Sanitary Engineering, at its last meeting promulgated the following regulations to cover this requirement:

Rules and Regulations Concerning Qualifications of Operators of Sewage Treatment Plants

(a) The term "operator" shall apply to any person who shall have active field supervision of a sewage treatment plant. It shall not apply to a city engineer, public works superintendent or other similar official who exercises only general supervision. There shall be at least one operator in charge of every sewage treatment plant operated by a state institution, city, town, borough or other municipal district or sub-division, or by any person, firm, institution or corporation providing sewerage facilities for 1,000 or more persons, or for lesser numbers when necessary in the opinion of the state department of health.

(b) Each operator must be in good physical condition so as to enable him to perform necessary manual labor at his plant.

(c) Each operator must submit evidence satisfactory to the state department of health that he is qualified: to read typed instructions furnished him by the state department of health; to keep necessary written records required by the state department of health; to operate various valves which direct sewage to different units of the plant; to operate sludge draw-off mechanisms; to clean and properly care for sludge drying beds and/or intermittent sand filters; to operate and make the simple tests required to keep chlorinating equipment, where supplied, in efficient operation or to make other simple necessary field chemical tests where necessary; to be sufficiently familiar with the end to be accomplished in the plant processes so as to recognize faulty operating conditions and if such conditions exist, to overcome them if practicable.

(d) Each operator of a plant employing machinery such as pumps, engines, electric motors, air blowers, etc., must submit evidence satisfactory to the state department of health, of previous mechanical training and experience, which shall be sufficient to enable him to properly care for and carry out minor repairs on mechanical equipment at the plant, and he shall have a general knowledge of the principles involved in the operation of the particular equipment for which he is responsible.

(e) Operators of plants employing activated sludge treatment or other processes involving a highly specialized knowledge of physics, chemistry or bacteriology must submit evidence satisfactory to the state department of health, of sufficient technical or specialized training along lines such as to qualify the operator to secure satisfactory operating results from a particular plant. Where a knowledge of laboratory technique is needed, the operator's qualifications shall meet the approval of the state department of health.

(f) Confirming and supplementing the above requirements, each operator shall possess a sufficient degree of application, initiative and judgment so as to enable him in practice to secure plant operating results satisfactory to the state department of health.

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Records of Wells in Texas

An investigation of the ground-water resources of Texas by the United States Geological Survey and Texas Board of Water Engineers, made for the most part since September, 1929, has covered thus far all or parts of about 30 counties. The Engineering Experiment Station of the Texas Agricultural and Mechanical College is cooperating in this work, and the State Board of Health has cooperated in making studies of the sanitary condition of the ground water in several counties. Thus far six mimeographed reports giving some of the results of these investigations have been issued and distributed to the public. Eventually reports covering the work are to be published by the United States Geological Survey as water-supply papers.

In connection with these investigations records have been obtained of more than 3,000 wells. In large numbers of the wells the records include size of well and total depth, depth to the water level, depth to the top of the principal water-bearing bed and thickness and character of the bed, method of lift, kind and amount of power used, kind of pump used, and yield of well from natural flow or under pump in gallons a minute. The records are being assembled and tabulated, and as fast as this is done copies of the tables are filed in the main office of the Geological Survey, Washington, D. C., and in the office of the Texas Board of Water Engineers, at Austin, where they may be consulted by the public.

CEMENT LINED WATER MAINS

A Symposium on Experiences of Users and Producers of Cement Lined Pipe*

ONE entire aftenoon session of the recent Convention of the American Water Works Association was given over to a symposium on the subject **"Cement-Lined Water Mains and Pipe."**

LEONARD P. WOOD, of New York City, as Chairman of the Association Committee on Corrosion and Protective Coatings, in making the introductory statement said that pipe lining for prevention of slight tuberculation, and resultant loss in carrying capacity of water mains (frequently 20 per cent in 3 years), had been considerably on the increase since 1923. In the years 1930-1931 about 13 per cent of the larger Cast Iron pipe produced by some companies had been lined with cement or some other protective material. The dependability of cement protective coatings was illustrated by the fact that a Portland cement lining in the Catskill Aqueduct of New York City had perfectly protected the steel for 18 years notwithstanding the very corrosive nature of the Catskill water.

Increased hardness and alkalinity of water, due to the leaching of calcium salts from the cement, constituted an objection to cement linings for a short period of time, but the development of a low soluability cement to overcome that objection is now under way. Another scheme to prevent solution was that of dipping the cement lined pipe in a bituminous bath. Tentative specifications stipulate an ⅛-inch minimum thickness of cement lining for pipe of 12-inch diameter and less: from 14 to 30-inch pipe should have a lining of 3/16-inch thickness and ¼-inch lining was stipulated for larger pipe. This thickness specification, he said, was about one-half that employed in English practice. Steel pipe required thicker linings (½ to ¾-inch for 24-inch) in order to compensate for the lesser rigidity of steel pipe and to thus avoid subsequent cracking of the lining.

Mr. Wood said that Jas. E. Gibson must be credited with the first use of cement-lined cast iron pipe in America when in 1922 he interested the American Cast Iron Pipe Company in making up 10 miles of such pipe to combat a peculiarly severe corrosion condition of soil and water. Cement-lined service pipe, wrought iron and steel pipe had been used, however, for 40 to 50 years with complete satisfaction.

Commenting on arguments concerning reduced carrying capacity of lined pipe—a theoretical objection—because of reduction of diameter due to the lining thickness, Mr. Wood said that as a matter of fact, because of the permanent smoothness of the lining, 6-inch and larger pipe could have twice the thickness of lining now applied and yet deliver more water than unlined pipe of equal sizes when the coefficient "C" of the Hazen-Williams formula had reached the moderate figure of 100 when applied to the unprotected pipe. Interestingly, the use of a 2-inch lining in the Catskill riveted steel shell aqueduct had made it possible to reduce the diameter by about 12 inches, resulting in a considerable saving in construction costs.

As for outside pipe protection against soil corrosion, investigations made by the U. S. Bureau of Standards in cooperation with coating manufacturers and the American Petroleum Institute had indicated that the ordinary thin dip coatings would not stand. Only thick, tough and uninjured coatings of bitumastic materials would stand up against corrosion in soil.

"Results Obtained from Cement Linings"—T. H. WIGGIN, Consulting Engineer, and also Chief Engineer of the Federal Water Service Company, New York City.

Mr. Wiggin said that he was a great believer in the protection afforded and the economy of using cement-lined pipe. Since 1927 he had prescribed its use by at least 90 water utility properties owned by the Federal Water Service Company. He thought that linings somewhat thicker than ordinarily specified was preferable and he therefore followed more along English lines of specifying thick linings (5/16 and ⅜-inch for the larger pipe)—stipulating ⅜-inch for pipe of 24-inch diameter and upwards. In respect to carrying capacities, tests had revealed that the coefficient "C" in Hazen-Williams formula had varied from 135 to 145 and he felt that 130 would be the low point unless peculiar slime growth might reduce the capacity in one instance under his observation. Unlined pipe (tar-coated only), on the other hand, had shown coefficients as low as 45 after some years of service and even with the least corrosive waters the figure had been but 95 to 105.

Mr. Wiggin said that it was therefore evident that the use of unprotected Cast Iron pipe constituted a gamble as to what one could depend on for its future service and capacity whereas with properly lined pipe (cement or bituminous) one could predict its sustained capacity for years to come. He considered that 130 would be a safe friction coefficient to rely upon for predicting future capacities in long-term planning.

JAMES E. GIBSON, Engineer-Manager of the Water Department at Charleston, S. C., said that his attention had first been called to the important losses in Cast Iron pipe carrying capacity in 1907. Corrosion and tuberculation was the proven cause. He had observed that a section of Phipps (patented) cement-lined wrought pipe gave a tremendously better capacity than did Cast Iron pipe of the same age (25 to 30 years of service) used in the same system. In 1917, shortly after he had taken charge of the Charleston, S. C., system, he had found poor service to be due to tuberculation of mains. Recalling the earlier observations in connection with the Phipps cement-lined pipe, he began to experiment with cement linings whereupon he procured 10 miles of cement-lined pipe from the American Cast Iron Pipe Company in 1922. Tests had thereafter been made at flow rates varying from 0.9 to 2.44 feet per second and the high coefficient observed was hard to believe, but none the less 135. Later tests on 500-foot sections showed some drop but again in 1930 after more than 7 years of service, in connection with the corrosive Charleston water, the coefficient recorded was on the average better than 140 with velocities up to 4.2 feet per second. A very recent and accurate test just made had shown that the coefficient averaged 139. Some recently installed 8-inch cement centrifugally-lined pipe had by test shown a coeffiicent of 153 (average) and 146 minimum. The new lining with an enamel-like surface after some use roughens slightly to the texture of an egg shell or slightly rougher. After 10 years of service the original Amer-

*NOTE: The papers and discussions in full which went to make up the symposium on "Cement Lined Water Mains" have been prepared by R. D. Wood and Company of Philadelphia, in mimeographed form for limited distribution.—Editor.

ican-lined pipe is about as good as new and all of the early fears of disintegration of the cement by the peaty corrosive water of Charleston had been dissipated. The added cost of lining seemed highly justifiable when one considers the added value to the system in terms of sustained capacity of the mains and thereby sustained value.

F. R. BERRY of the American Water Works and Electric Company, by letter referred to the company's entire group of plants. He said that experience had justified almost exclusive use of cement-lined pipe. Frequent check-up over the past 6 years had indicated no deterioration of linings.

H. O. SWEET, Superintendent of the Birmingham (Ala.) Water Company, by letter stated that cement-lined pipe had been first installed by him in 1925 and used exclusively since. Well over 100 interior inspections had shown no spalling off of lining or other deterioration. Even at the corporation cock no tuberculation had been observed, showing that drilling through had not depreciated the protection at these points. Lining as thin as 1/16 inch had been found in good condition after 5 years' service. Mr. Sweet had found no reason to believe that linings need be greater than ⅛-inch thickness but the Birmingham water is not very aggressive nor has the observation period been very long.

D. A. HEFFERNAN reported excellent service from cement-lined pipe (8 years of use) at Milton, Mass. T. J. SKINKER said the same for St. Louis after three years of use. A test on a 20-inch line had shown an unbelievably high coefficient (around 180) and a recheck was being made on that account.

"Cutting, Tapping and Handling Cement-Lined Pipe"—REEVES J. NEWSOM, President of the Community Water Service Company, New York City.

Mr. Newsom said that 75 per cent of his company's plants used cement-lined pipe and the managers of these had agreed that no special handling or storing of the pipe was necessary to preserve the lining intact. Lined pipe was cut by ordinary methods and the same applied to tapping. Where slight looseness of the lining had been observed as the result of long storage such had disappeared upon filling the line with water or placing it in service.

J. E. GIBSON, commenting on experiences in handling lined pipe said that no particular care is required. Cutting with the old cold cut cleaver-hammer or the newer wheel-cutter gave no difficulty. Tapping practice was the same as used on unlined pipe. Hair-line cracks or looseness of linings during storage would disappear when the cement is wetted again. Some little breaking back of the lining at the cut had been observed but was of no consequence.

T. H. WIGGIN said that he could agree with the above experiences except that in cutting the lining would break back sometimes three-quarters of an inch, but usually not more than one-quarter inch. There seemed to be no practical difficulties involved in the handling and laying of cement-lined pipe.

D. A. HEFFERNAN at Milton, Mass., had not experienced the breaking back trouble. He used Sand-Spun pipe and a dog chisel. In using the cutter it did not have to go all the way through.

R. G. YAXLEY, Superintendent of Water Works, Waterford, N. Y., confirmed the experience of Mr. Heffernan. With the Ellis type of wheel cutter the pipe snaps off before the cutter cuts all the way through the pipe.

At Kalamazoo, Mich., L. A. WITTERS had installed 8,000 feet of 24-inch lined pipe using the cold cut method of cutting but without any bad experiences.

H. O. SWEET of Birmingham, reported that an even break was had in cutting. Long storage was not advisable because check cracking and looseness of lining increases with sizes above 12-inch. Sizes above 16-inch should be laid as soon as possible after the lining has set properly.

"The Separation and Cracking of Linings"—T. H. WIGGIN, Chief Engineer, Federal Water Service Company, New York City.

Mr. Wiggin thought perhaps the greater thickness of lining at his plants had prevented any noticeable separation of linings from the pipe. No cracking of consequence had been noted. Where looseness and cracking occurred it was of no concern because the water would cause it to swell and tighten: the cracks would heal shut.

W. R. CONARD, Consulting Engineer, Burlington, N. J., believed that a thicker "lean" mix lining was generally preferable to a thin "rich" lining, if shrinking, breaking back and cracking was to be avoided.

REEVES J. NEWSOM had no bad experiences from separation and cracking of linings. Cracking of linings in fittings was more noticeable than that in the pipe but recent practice has corrected this difficulty to a marked degree. Increased thickness of lining has been helpful.

D. B. STOKES, Vice-President, U. S. Pipe and Foundry Company, Burlington, N. J., said that in manufacturing lined pipe care was taken to thoroughly clean the pipe before lining. Grease, if not removed, would cause the lining to loosen. Temperature of cement-lined pipe under the direct sun might reach 140° F. and cause too rapid dehydration and shrinkage of the lining. Temperatures between 40 and 90 degrees F. had caused no troubles. A rich mixture of cement mortar (stronger than 3 cement to 1 sand) has been found the most acceptable formula. New lined pipe was passed through a curing process, being kept wet down 48 to 72 hours, and the lining was kept damp thereafter while in the yard by sprinkling at intervals. It was the opinion of the U. S. Pipe and Foundry Co. that pipe free from cracking and lining shrinkage could be produced without difficulty.

H. Y. CARSON, Director of Research, National Cast Iron Pipe Company, presented discussion by letter in which he reviewed the experiences had with lining pipe for the first (Charleston, S. C.) installation and progress made since in improving the practice. Loose linings were not to be considered as serious because practice had shown as much. The cost of correcting the trouble could not be justified.

J. T. MACKENZIE, Engineer, American Cast Iron Pipe Company, Birmingham, Ala., took Mr. Moore's place on the program. His experience had not been that increased thickness of lining had reduced loose spots: it had in fact been the opposite. He did not find a lean mix to shrink less but rather more. He confined his remarks to sizes under 24-inch and possibly thought the experience might vary with larger diameters.

"Solubility of Cement Linings"—ROBERT SPURR WESTON, Consulting Engineer, Boston, Mass.

Mr. Weston, being absent, his paper was read by Mr. Wood. The author reviewed the reasons for attack of aggressive waters and the dissolving of certain alkaline products from the cement lining with an increase in hardness of the water. The rate of solution was high at first and then rapidly dwindled and thereafter a long life of the lining was assured if the thicker coating was used. In lieu of a low-solubility cement and thick coatings the lining should be protected by painting with bituminous material or by dipping.

H. O. SWEET of Birmingham, reported no complaints from hard or caustic water except on dead ends. In

such cases the trouble cleared after the maximum of 22 days of dead-end flushing. No deposits in meters have been found to result from the material leached from the lining.

JOHN R. BAYLIS, Chemist, Chicago Water Department, said that he believed cement lining the most durable of coatings for water pipe because of its highly resistant silica content in the form of sand which remains after leaching to protect the pipe. He would suggest a mixture of 1.5 per cent to 1 of sand rather than a richer mix. Mr. Baylis then explained the leaching process and the eventual sealing of the void between the sand with calcium carbonate while next to the pipe the alkali will be strong and prevent corrosion. Eventually, but slowly, all of the calcium is leached or dissolved out but the skeleton structure of sand and silicates remains intact to protect the pipe.

Mr. Baylis advocated the application of bituminous paint to extend the life of cement linings and avoid alkali water during the early weeks of service and believes that such practice will come into common use. In lieu of this bleeding of the mains will relieve the alkali condition of the water objected to.

E. L. CHAPPELL, National Tube Company, Pittsburgh, Pa., presented a very thorough analysis of leaching processes, and said that the cement employed in linings should preferably be of high silica and low solubility and alkalinity and should be painted to render it even less soluble.

D. B. STOKES described a new cement which was being developed for linings and which was now being applied experimentally by his company (U. S. Pipe and Foundry Co.) but for the present he thought the use of bituminous impregnation or painting by hand or spray gun was to date the most acceptable method of preventing solubility.

REEVES NEWSOM cited cases of meter stoppage due to leaching of cement linings and felt this trouble needed correction.

DR. F. E. HALE, Director of Laboratories, Department of Water Supply, New York City, presented, in abstract, the results of long-period studies of the solubility of cement linings. The conclusions drawn indicate the value of bituminous paint applied to prevent leaching. Certain paints were listed as approved.

(In a future issue the results of the New York City studies will be presented in an article by Dr. Hale.—Editor.)

Lining of Fittings

Discussion of the **"Lining of Fittings"** was opened by W. W. BRUSH, Chief Engineer, Department of Water Supply, Gas and Electricity, New York City, who said that most fittings in the New York City system were lined with bituminous enamel. Cement linings were allowed if applied by hand trowel.

T. H. WIGGIN said that early linings in fittings had been too thin and ⅛ to 3/16-inch seemed to be better practice. He believed greater care should be devoted to lining of fittings and the quality of workmanship varied considerably so far as he had observed.

D. B. STOKES said that foundry practice was to brush on the lining of small fittings (such as 4-inch) wherein two to four coats of mortar was applied at 30-minute intervals. Larger sizes subject to hand-work were lined by men wearing rubber gloves. On still larger sizes trowels are used and later the lining is rubbed down to smoothness.

H. O. SWEET said that he had unsatisfactory experiences with cement-lined fittings.

Exterior Coatings

In discussing **"Exterior Coatings"** Mr. Brush said that soil corrosion in New York City was not a factor and that coating was an unimportant item. They therefore had no rigid specification.

D. B. STOKES said that the best method of coating the outside of cement-lined pipe is to suspend the heated pipe (prior to lining) over the standard hot tar dipping vats and to apply the material by hand brushing. The damaged spots on the coating resulting from handling in the centrifugal lining machine was touched up by hand afterward.

T. H. WIGGIN thought that outside coating of pipe had a psychological effect on the citizen who observed the shining product. If a rust discolored pipe were used they would consider it to be inferior or possibly second-hand pipe. The "Sidewalk Committees" were sometimes important groups to satisfy and they would highly disapprove of "second hand pipe" being put off on them.

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People in This Ohio Town Are in Dead Earnest

According to Ohio Health News for Sept. 1, residents of Pemberville, a village just inside the eastern border of Wood County, are very much "up in arms" in support of a demand for installation of a water works system, through the medium of a prospective grant and loan under the National Recovery Act. Council, with the exception of one member, opposes the idea, and the mayor also is fighting it.

According to the Pemberville *Leader*, the village has been warned by the State Department of Health of the advisability of such installation, but has been unable to finance it under ordinary methods available under Ohio laws. It recognizes, in the public works section of the NRA program, a feasible and economical opportunity to obtain a needed improvement under most favorable conditions. Mayor and council are adamantine in opposition.

Having first refused to recognize the plan in any way, the council, spurred by the attitude of 30 or 35 citizens who insisted on being heard, adopted a resolution to submit the proposal to voters at the November election. This was protested by all the citizens present, on the ground that delay until that time probably would make it impossible to receive governmental funds. Council, however, stood pat, and the resolution was adopted.

Then the people "got busy." There are less than 1,000 of population (the 1930 census showed a total of 960), but two petitions were circulated at once, demanding the immediate drafting of the necessary plans to accompany a properly drawn application to be submitted to the Ohio Advisory Committee, thence, if and when approved, to be sent to Washington. In less than 72 hours there were more than 200 signatures of voters on the two papers, which must approximate two-thirds of the voting population and represent four-fifths of the number of families in the community; i.e., a very large proportion of the potential water works connections.

What has since transpired has not reached this editor's desk; but it seems fairly safe to forecast that, as the people evidently know what they want, they will obtain it, notwithstanding—again according to the *Leader*—that the mayor told council that if the petitions were received and acted on, he would resign.

MEETING OF THE NEW YORK SECTION OF THE A. W. W. A.

Discussion of N. R. A. Financing of Utilities Featured

THE New York Section of the American Water Works Association held a two-day meeting on August 24th and 25th at Utica, New York. The attendance of close to 150 exceeded expectations, when considering the fact that the most severe and widespread storm in years preceded the meeting.

Following the opening of the meeting by Chairman Frank C. Hopkins of the Utica Consolidated Water Company, there was an address of welcome by the Mayor of Utica.

Industrial Recovery Act Discussed

An outline of **"The National Recovery Act as it Applies to Water Works Construction"** and improvements, was presented by W. W. BRUSH, Chairman of the New York Section, National Recovery Committee for Water Works Construction.

Mr. Brush said, that drafting of Codes for industry had delayed progress with public works developments, but that the Federal organization was now ready to put into effect the Public Works Section of the Recovery Act. He had been informed through the Engineering Division of the State Department of Health of the recent ruling that the original fee of 1 per cent to be charged by the government in arranging loans was to be dropped—making the interest rate of 4 per cent the single cost of borrowing. He said that acceptable projects would be considered on the basis of how quickly men could be put to work on them and such projects as the extension of mains or other additions to existing works would be put through promptly. One requirement to accompany applications would be an estimate of the number of men required on the project. Contract or day labor would be equally acceptable but all men put to work with N.R.A. funds would be limited to an 8-hour day and a 30-hour week at a rate of 50 cents per hour. He explained that the 30 hours per week limit was to be considered on the basis of average weekly employment during any 30-day period.

Mr. Brush pointed out the fact that municipalities that failed to take some advantage of the present situation were probably losing sight of the fact that they would be helping finance nation-wide improvements without reaping any of the benefits and would be passing up an opportunity to procure improvements at about one-half the normal cost. Whether tax-payers realized it or not, they would be contributing funds (taxes) to be handed over to other localities as grants. For this reason, if nothing more, they should find it advantageous to keep their money at home by availing themselves of the opportunity to secure a just share of the grants and the advantage of the low cost of borrowed money for 25 years to come. He did not believe that tax-payers, and municipal authorities, had considered this side of the picture or else there would be more applications on file.

P. S. WILSON, Executive Secretary of the National Recovery Committee for Water Works Construction, reviewed the activities of this Committee since June. He said that every section of the country now had its local Recovery Committee working in coöperation with the National Committee. There had been disappointment that work on improvements had not gotten under way earlier, but it was increasingly apparent that the slow progress of the Relief Administration had been necessary to avoid pitfalls by insuring a thorough coördination of public works construction with industrial codification and regulation. The time had arrived now when more action by the Public Works Section of the N.R.A. could be expected.

The Effect of State Legislation on the N. R. A.

JAMES C. HARDING, Consulting Engineer of New York City, in his timely paper on the above subject stressed the need in many states for legislation which would at least temporarily remove all impedimentary restrictions on municipalities seeking loans under terms of the Recovery Act. This situation was about to be cleared up in New York State by the passage of Introductory Bill No. 12 just a day or two previously. Governor Lehman had introduced this bill himself, it being drawn with the aid of the mayor's conference of New York State and the State Department of Health.

This new legislation in brief states that the existing public emergency warrants the voidance of local laws or regulations which may hamper or delay progress in taking advantage of N. R. A. loans and grants; that such existing laws shall not longer restrain governmental authorities from applying for N. R. A. loans before having held public hearings, having published public notices or having put the financing to a vote by tax payers. Further, the bonds offered may be serial or sinking fund bonds—either to be sold as seen fit.

Mr. Harding said that two other bills, known as the revised Desmond Bills, had not been acted upon before legislative adjournment. These bills are not restricted to N. R. A. loans and legalize the issuance of revenue bonds secured by a mortgage lien against water works or sewerage properties provided that the operating costs of the utility be completely covered by service charges for sewerage or the sale of water.

Mr. Harding promised that the Legislative Committee of the New York Section, of which he is chairman, would take steps in an attempt to have restrictions removed from certain existing laws, applying to new water supply projects.

Technical Papers

"Recent Studies on Jointing Compounds"—JAMES HANNON, Jr., Consulting Engineer, Pleasantville, N. Y.

Mr. Hannon said that his paper might be more appropriately titled "Observations on Joint Compounds" during several years of experience with lead substitutes on 6 to 18 inch pipe lines. Listing the arguments for and against the use of lead substitutes, he said that the economy due to elimination of caulking and cutting bell holes, when using compounds, was freely admitted. As to the argument that lead would stand vibration better, he cited experience with parallel mains through swampy ground and under a highway wherein the leaded line had, even after recaulking, leaked worse than that jointed with compound. In another instance a hydrant set with compound had been bent 30 degrees and straightened up by jacking without trouble resulting.

Mr. Hannon gave experiences and data to indicate that

the specified limits for leakage through compound joints on new installations was more liberal than need be. The commonly specified, "not more than 1 gal. per foot of joint per 24 hours at 100 pound pressure," had never been reached in his experience. Actual tests on a variety of lines had shown between 0.38 and 0.84 gallons per foot per 24 hours. A figure of 0.6 gallons was the observed average for all lines tested after 90 days. The pressure employed had not seemed to be an important item and leaks seemed to take up faster under high pressure than low ones. Indicative of the effect of time on the "healing" of leaks, he had observed the following leakages at 150 lbs. pressure: Ten days after placing main in service it had been 0.65 to 0.95 gallons per foot of joint; after 15 days 0.72 gallons; after 23 days only 0.52 gallons and after 9 months, but 0.12 gallons.

From such experiences as he had had, he would say that the delay in making tests for leakage on new installations need not exceed 10 days after filling the line and that even a shorter period might be allowable with due consideration being given the healing rate factor.

In making joints on pump suction lines he had found the use of compounds unsatisfactory because of air leakage in. Experience with enamel coated pipe had shown that the lining would not melt when in contact with hot joint compound at temperatures used in practice.

In conclusion he could say that the average cost of using lead substitute had been well under the cost of jointing with lead; that leakage had been less with compound jointing; that not more than 0.75 gallons per foot of joint per 24 hours would be an acceptable specification for leakage limits; that 10 days was sufficient time to wait before making leakage tests and that an earlier test might well be made with predictions as to take up in most instances. His experience had been that training men to pour compound joints properly was less difficult than training them in the use of lead and that re-caulking of lead joints was not so effective or simple as it might appear.

F. S. HOPKINS, in commenting on the durability of compounds, referred to the use of lead substitutes for at least 48 years and for the past 13 years the Utica Consolidated Water Company had used compounds exclusively.

E. T. CRANCH, superintendent, New Rochelle (N. Y.) water works, said that they had actually caulked new compound joints lightly to hasten the tightening up of leaks.

A representative of the Public Service Commission related experience with a joint compound wherein the specification had been 0.6 gals. per foot of joint on a 12-inch main but by test had been one-half of that.

"Development of the Automatic Zeolite Water Softener"—S. B. APPLEBAUM, Chief Engineer, Permutit Company, New York City.

Mr. Applebaum said that softening of water supply had been shown to result in an average total saving per household of $30.00 per year. The Zeolite process had the advantage of producing no sludge and was naturally adaptable and most economical in connection with clear waters, notably ground waters. Zeolitic softening introduced into America 20 years ago had been rapidly increasing in favor since 1928, during which period most of the 50 municipal plants now in use had been installed.

The removal of iron and manganese, by Zeolite units alone or in combination with softening, had proven practical. One plant in Ohio was removing 300 parts per million of hardness and an equal quantity of iron. He said the green-sand type of Zeolite had proven the most practical for the municipal field and the developments in brine economy had reduced the salt requirement to 0.5 lbs. per 1000 pounds of hardness removed.

Not content with improvements to manually operated Zeolitic softeners, Mr. Applebaum said, that the Permutit Company had recently perfected the fully automatic softener, the operation of which he explained and illustrated with lantern slides. The cleverly designed rotating multi part valve was the heart of the automatic softener which operates electrically to carry out, in rotation, the lackwash, the injection of brine and solution containing a definite weight of salt, the subsequent emptying of spent brine and the rinsing of the Zeolite bed. One might add two other steps, that of cutitng the unit out and replacement in service, all done automatically after the passage of a predetermined volume of water through the softener. An ordinary meter is used to make electrical contact which starts regeneration operations after each run of a given volume. Mr. Applebaum listed several advantages of the automatic softener, among them being the adaptation of smaller units with higher efficiency and more frequent regenerations—i. e., every 4 to 6 hours. Salt requirement was thereby more exact and less waste results. Furthermore, no watchful-waiting was necessary in determining when to regenerate, therefore less attention was required and there was no danger of getting hard water through the softener. One operator might, as a consequence, handle a very large plant single handed.

P. S. WILSON said that he did not think that Mr. Applebaum had placed sufficient emphasis on the value of Zeolite for iron and manganese removal in connection with well supplies. The single pumping operation made the scheme more attractive economically than those requiring double pumping with aeration and filtration intervening.

"Why Valves?"—E. K. WILSON, Chief Engineer, The Pitometer Company, New York City.

Mr. Wilson's paper was read by Mr. L. C. Hough, also of the Pitometer Company. It dealt with the subject of proper maintenance of valves on distribution systems and reviewed case records of valve conditions found during surveys made by the Pitometer Company. It was clearly demonstrated that valves installed to control the flow of water through a system in many cases provided a menace or hazard rather than a safeguard. The number of neglected inoperative, damaged or partly opened valves located in the reported surveys was surprisingly large. One of the 10 surveys reported disclosed 27 per cent of the valves to be defective or inoperative. Conditions in larger cities had frequently been as bad as those found in the smaller ones. Lack of adequate records covering testing, maintenance and use of such valve had, he thought, been responsible for the conditions found.

The author offered suggestions to better conditions which included adequate marking of left handed valves and keeping of records of operation of valves on with the number of stem turns required to close each one should be indicated. In closing valves, he said it was good practice to always back off an apparently closed valve and reclose it to make certain that nothing had been lodged under the gate. Counting the turns from full open position would verify the complete closing of the valve.

"The Development of Utica's Water Supply"—GEO. C. HODGES, Chemist of the Utica Consolidated Water Company.

Professor Hodges in an illustrated talk reviewed the history of the Utica Water Supply from 1802 to date. In commenting on quality of the Utica supply he said

they had a very satisfactory industrial water of only moderate hardness. Like many, they had had taste and odor troubles and several things had been tried to eradicate these troubles. The most successful had been the ammonio-chlorine process and he said he could recommend it highly for consideration by those faced with taste troubles.

On the afternoon of the 25th, following adjournment, many of those attending the meeting inspected the works and reservoirs of the Utica Water Company.

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Are There Cyclonic Whirls In the Ocean?

By HALBERT P. GILLETTE

AT the 1932 annual meeting of the American Geographical Union a very instructive paper relating to the Gulf Stream was read by Phil E. Church. From an analysis of ocean temperature records reported by steamship officers, Mr. Church was able to show that the Gulf Stream is a relatively narrow ribbon of hot water, only 50 to 70 miles wide, having very definite lateral boundaries. Also he proved, for the first time, that this stream exists during every month of the year.

One of the most remarkable features of this great current is its proclivity for sending out migratory whirls that "seem analogous in nearly all respects to atmospheric lows." Five years ago the writer advanced the hypothesis that cyclonic whirls are generated in the ocean in the same manner as in the air, and that in both cases ascending currents of electrons rotate under the influence of the earth's magnetic field. Mr. Church says: "The water-eddies apparently pass through the same stages of generation, development, and occlusion as the atmospheric lows, though at a much slower speed."

The narrowness of the Gulf Stream, its well defined boundaries and its direction of flow lead the writer to believe that this stream contains a series of water cyclones of 50 to 70 miles diameter, that are propelled gyroscopically. It is noteworthy that the general course of the Gulf Stream is the same as that of tropical cyclones. It has been supposed that it was generated by winds, but the narrowness and well defined boundaries of the stream make that hypothesis untenable. Moreover, Mr. Church has found that in winter whirling masses of water leave the Gulf Stream and travel northeastward, at right angles to the prevailing northwest winds. "Thus it appears that these masses at this time of the year, at least, can not be wind-driven."

Two years ago Lieut. E. H. Smith published a monograph (abstracted in Monthly Weather Review, Nov., 1931), in which he described an ocean whirl off the coast of New Foundland. Icebergs are carried around in a circle about 50 miles in diameter. He regards that whirl as being an oceanic cyclone similar to atmospheric cyclones. In Engineering and Contracting, April, 1932, the writer pointed out that this oceanic cyclone near New Foundland could not be caused by the permanent atmospheric cyclone near Iceland, for they are not concentric. Now Mr. Church adds to Lieut. Smith's evidence of oceanic cyclones by showing that certain oceanic whirls migrate from the Gulf Stream just as atmospheric whirls migrate.

If the Gulf Stream is driven by and consists mainly of cyclonic whirls of water, then the elevation of the surface of that stream must be greater than that of the adjacent water. In consequence water would flow off laterally and descend. Descending it would push the cool deep water upward. Hence there should be a zone of upwelling cool water which should be particularly marked on the northwestern side of the Gulf Stream. Mr. Church has found evidence of such an "upwelling zone" of cold water. It forms a band only a mile or two wide lying in a wide cold water area.

In September both the Gulf Stream and this cold water area are warmest and in March they are coolest. It is noteworthy that in September and early October atmospheric cyclones in Iceland and Alaska are most active, and that the same is true of tropical cyclones. The same should be true of cyclonic whirls in the ocean, and this would therefore explain the higher temperature of the Gulf Stream in September. Six months later the opposite should be the case, if cyclonic activity is due to magnetic rotation, as the writer believes. In September the sun's north pole inclines most directly earthward, and in March its south pole does. There is a 12-month cycle in sunspots whose peak is in March and whose valley is in September. It is clearly brought out if all years at and near the 11.12-year sunspot peak are excluded.

In detail, as well as in general aspect, the oceanic phenomena discovered independently by Lieut. Smith and by Mr. Church fit the writer's electron theory of fluid rotation and the migration of fluid cyclones.

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George E. Barnes Named Head of Civil Engineering at Case

George E. Barnes, New York City, has been appointed Professor of Hydraulic and Sanitary Engineering at Case School of Applied Science, according to an announcement made by President William E. Wickenden.

Professor Barnes was graduated from Massachusetts Institute of Technology in 1923 with the degree of Civil Engineering. While a member of the faculty of the University of Florida for six years, he also engaged in private practice as consulting engineer.

In 1929 he became designing engineer for Fuller and McClintock, New York City, in which offices the designs of Ward's Island Sewage Treatment Plant, for the city of New York, were executed. After completion of this work he joined the engineering staff of the city of New York, where he has been employed until his present appointment. He is 35 years of age, and as such is one of the youngest men to head a major department in an American engineering college.

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Some Rainfall

The *Intake*—a monthly publication of the Department of Water and Power of Los Angeles, Calif., publishes some amazing figures on rainfall in the Pacific Northwest country. To arid Los Angeles the amount of rainfall at Gray's Harbor, Washington, is a dream perhaps and why not?

The *Intake* figure is 9 feet of rainfall in 1932 for Gray's Harbor County, representing 3,500,500,000,000 gallons of water for that one county. Los Angeles' consumption being 156,000,000 gallons per day, the 1932 precipitation of Gray's Harbor County would (excepting evaporation and seepage) supply Los Angeles for more than 60 years or New York City (consuming 1,000,000,000 gallons per day) for almost 10 years. Some rainfall—unless the *Intake's* "slide-ruler" slipped a cog in making the calculation.

EDITORIALS

What State Sanitary Engineers Have Done

IT was once said by a medical man and a prominent health official, in referring to sanitary engineers in public health work, that they were "certainly harmless; and they may be useful." It is not always what is said that is as important as is how it is said. No matter how one interprets the word *"may"* it is hardly necessary to assert here that State Sanitary Engineers have well proven their usefulness. It is a privilege, however, to comment on how well *"they"* have done so.

The State Sanitary Engineer is not as a rule an individual who gets on the front pages of newspapers, nor does he care for publicity. He is content to do as much good as he can for the personal satisfaction of the doing. He is perhaps to be criticized for not taking his due share of the "spot-light"—even at the hazardous risk of outshining the medical man. In the ordinary "run of mine" activities of engineers in public health work—and their duties are many and diversified—the public hears little of the accomplishments of this important group of public health workers. It is only when some form of distress puts in its appearance that the State Sanitary Engineer is appreciated for his true worth. In times of disaster—flood, drought, hurricane, earthquake—he is called into the front line trenches and is then appreciated as never before—perhaps by some for the duration of the calamity only, but by many he is justly remembered afterward.

That the last is true, is borne out in a recent case: An incoming Governor for some reason felt called upon to replace the State Sanitary Engineer but he soon learned to his dismay that he had made a most unpopular move. The demands for reinstatement from the numerous municipalities, which this engineer had served so faithfully and well, resulted in his prompt reappointment. Such demonstrative appreciation can but be encouraging to State Sanitary Engineers. To know that credit still comes to him to whom credit is due, must make them feel more secure in their positions, which have appeared to be none too certain in some cases in recent times.

That State Sanitary Engineers not only *"may* be useful," but have been and will continue to be extremely useful during the attempts of the country to pull out of this nation-wide unemployment situation, can be amply demonstrated. It is gratifying that the superiors of these men, from state health officers to governors and even to the President himself, are showing recognition of the good work being done by engineering divisions of State Health Departments in this emergency. It is to be hoped that after this particular emergency has passed that the part played by these engineers, at a time when their hands should have been strengthened instead of being weakened by reduced appropriations and staff personnel, will be remembered.

When it came to a matter of looking toward the construction and betterment of public utilities as a means of re-employment, the State Sanitary Engineer became the logical person to whom to turn. He was promptly asked for estimates of what was needed by the several municipalities in the various states which would entail improvements or the construction of new water works, sewerage and other sanitation projects. Important committees from various associations promptly turned to them for reports of needed improvements and the approximate size in terms of expected employment and estimated costs. Such reports were assembled for forwarding to officials at Washington. Who else could they have gone to? The State Sanitary Engineer knew in advance what was needed in his state and so reported without loss of time and expense which would otherwise have been required in assembling such important data. The preliminary survey could be made by referring to his files, but the completed survey required some field work which was done quickly and effectively.

Then followed the Reconstruction Finance Corporation which received many applications for loans to municipalities for public works betterments, stimulated in many instances by the work of State Sanitary Engineers. It is now well known that this means of financing public works and stimulating employment failed because of the too rigid restrictions thrown in the paths of the would-be borrowers by the R. F. C.

Then came the "new deal" and the National Relief Act with its section on Public Works Construction. Once again the State Sanitary Engineer was called upon to help in the matter of stimulating a demand for municipal improvements and applications for loans from the N. R. A. Dropping everything possible—meaning pretty much every other activity in some cases—engineers of State Health Departments ever since the passage of the National Relief Act in June, have worked hard and put in long hours encouraging cities and town officials to avail themselves of this opportunity to borrow money offered under the most favorable of conditions by the Federal government for needed projects. These men appreciated the value of such work to the nation at large and went out to do their bit in the war on depression. They have had to do more than make public addresses and hold private conferences to stimulate municipalities to go forward with new work: they have had to answer many detailed questions, assist in the drafting of applications for loans and in shaping up the required information to accompany applications—all in addition to studying and approving the plans covering the projects.

In many states, the State Sanitary Engineer has taken a prominent part in getting through emergency legislation to make legal the issuance of revenue bonds by municipalities for use as security, first with the R. F. C. and now with the N. R. A., and to render it possible for municipal authorities to apply for Federal loans without holding public hearings or bonding elections. Twenty-six states now have enabling acts similar to, if not quite as broad as, the recently passed New York act, briefly reviewed elsewhere in this issue. The New York act is worthy of note as a measure intended to speed the Public Works program of the Administration by removing obstacles preventing prompt financing of such work.

Particularly effective has been the work of the Sanitary Engineering Divisions of Ohio, New York, Kentucky, West Virginia, Illinois and Texas. In Pennsylvania the Governor's Emergency Public Works Committee, on which the State Sanitary Engineer has served as Engineer, has functioned as the stimulating body to promote public works. Recently, however, the Engineering Division of the Department of Health has taken on the work with vigor. From the conception of the R. F. C. and until the completion of the Public Works

organization of the N. R. A., the State Sanitary Engineer of Pennsylvania has served as liason-officer between the several state engineers and the administration in Washington.

Largely as the result of the telling efforts of the New York State Department of Health through its dissemination of informative literature pertaining to the N. R. A. program, backed up by personal contact and letters of explanation, more than 50 municipalities in New York State have applications ready for action by the N. R. A. and an equal number are expected to make application. In Kentucky 20 municipalities, asking for roughly $2,000,000, are ready to start work, when the applications for loans have been favorably acted upon by the Federal Board, and 40 more towns and cities are prospective applicants. In West Virginia between 15 and 20 applications have been made ready for filing if not now filed —one alone representing a $3,000,000 sewerage project. An equal number are prospective applicants. In Texas not less than 30 municipalities have loan applications in shape for filing.

The situation in Ohio is outstanding. The Engineering Division of the State Health Department began its vigorous program of stimulation and promotion of public utility betterments in April and for the past five months the entire personnel of the division has been so engaged. The results speak for themselves. As the time of this writing there were 165 applications, from 52 municipalities and 5 counties, on file for loans. The estimated cost of these projects amounts to a total of $37,562,291. In addition, applications are in the course of preparation for 76 additional projects in 54 municipalities. The estimated cost of these is $17,861,950, making a grand total to date of roughly $55,500,000 in new work contemplated in Ohio. This came as a result of having made personal visits to 150 cities and office contacts with many others. The State Sanitary Engineer of Ohio lists another 133 projects in 120 municipalities which he terms fair "prospects," and points out that even this imposing list does not represent all of the needed sanitation improvements in Ohio.

Without an attempt to set forth the accomplishment in all of the states—the few mentioned will serve to emphasize the fact that State Sanitary Engineers have again rendered meritorious service in another and great mergency, and for it they should be recognized by the N. R. A. in some appropriate manner.

The day will come when municipal officials will doubly appreciate the sound advice given by State Sanitary Engineers in urging the making of needed improvements now while such low costs of financing the project through the N. R. A. are available.

Rainfall and Crop Yields

UNDER the title above given a very interesting four-page article by I. Gutman was published in the June issue of "Civil Engineering." Mr. Gutman's calculations relative to certain annual wheat crops and annual rainfall in England lead to the conclusion that there is a negative correlation coefficient of 0.322, which is too low to be very significant. The data used in this calculation cover the years 1853 to 1908 on certain parcels of land at the Rothansted Experimental Station.

Mr. Gutman briefly discusses a published report by H. B. Lynch, M. Am. Soc. C. E., to the Metropolitan Water District of Southern California, entitled, "Rainfall and Stream Run-off in Southern California Since 1769." Mr. Lynch used certain crop yields in early California missions as a guide in estimating rainfall fluctuations. Mr. Gutman points out that there were great inconsistencies as to the yields of barley, wheat and corn in those mission farms, and infers that no reliable conclusions as to annual rainfall can be drawn from the data. He also points out that one of the controlling factors is the time of year when the rain falls. He says:

"Above a certain minimum, subnormal rainfall, favorably distributed according to the requirements of plant growth, will produce better crops than a supernormal annual rainfall unfavorably distributed. Favorable distribution means above all adequate rains in the spring. Thus, in a study of rainfall and crop production in the agricultural district around San Francisco Bay, it was found that very satisfactory crops were produced in seasons when the rainfall was considerably below the average, provided the total rainfall for the months of March, April, and May was not less than 4 in."

Although Mr. Gutman does not mention it, the rainfall during the spring and early summer largely determines the thickness of tree-rings. Hence tree-ring thickness is not entirely satisfactory evidence as to annual rainfall. Yet Prof. Douglass found that in Arizona the annual rainfall and the thickness of rings of pine trees were in general correspondence for about 75 per cent of the years.

The writer regards tree-rings as invaluable guides in discovering cycles of rainfall. By aid of tree-rings he has established the existence of several cycles that have long been in dispute. For example, the Arizona pines and the California sequoias both show rain cycles of 8.85 and 18.60 years, which will have coincident peaks in 1934. Both of these are lunar periods. The moon's orbital axis rotates in 8.85 years, and its nodes rotate in 18.60 years. Evidence of weather cycles of about these lengths had been found by several investigators, but since accurate weather records seldom antedate the year 1730, there have been too few cycles of 8.85 years or longer to establish either their reality with certainty or their length with accuracy. Brunt, using Schuster's periodogram analysis, found a European temperature and pressure cycle of 8.83 years. It is of the utmost importance to know whether this cycle is 8.83 years as determined by Brunt or 8.85 years as determined by the writer. Brunt's data cover man-kept records since 1760 A. D. The writer's data cover nature-kept records (sequoias) since 1300 B. C. Hence there can be no question as to which estimate of the length of this cycle is the more reliable.

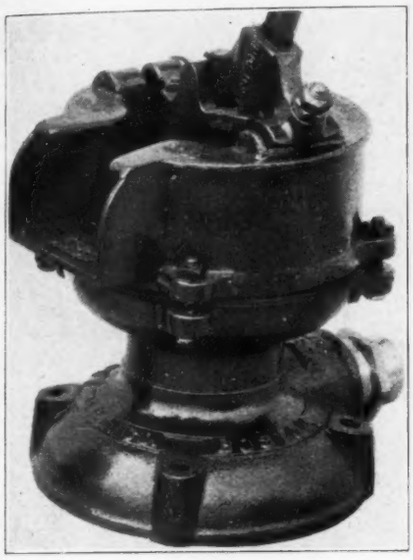
Prof. Dinsmore Alter has recently announced the finding of an English rain cycle of 9.38 years. Turner had previously found a magnetic cycle of 9.2 years. The writer has found a tree-ring cycle of 18.60 years, with evidence of an intermediate peak, thus making a cycle of 9.30 years. Are Atter's and Turner's cycles merely close approximations to a true length of 9.30 years? This question seems to be answerable only by using records kept by Nature, namely, tree-rings and "varves" or annual laminæ of silt deposited in ancient lakes. There is only one man-kept record of sufficient length to throw much light on this particular cycle, namely, the annual high-and-low water levels of the Nile. These begin in 622 A. D., and an unbroken series is available for about 800 years. Thereafter there are several bad breaks in that record.

NEW EQUIPMENT AND MATERIALS

Utilitarian Diaphragm Hand Pump

The Edson Corporation of South Boston, Mass., manufacturers of hand and power operated diaphragm pumps of various sizes, announce the No. 1 Edson—"the smallest and most efficient non-chokable diaphragm pump made."

Small in size (weighing but 53 pounds) it is not so small in capacity. It will discharge 1,400 gals. per hour under a suction lift of 25 feet through its 2-in. suction hose. This little pump is equipped with valves of brass and rubber throughout and is especially suited for carrying a part of maintenance truck equipment, for pumping out meter boxes, manholes, vats, trenches, or cesspools for which purpose a light weight readily portable "vest pocket edition"—so to speak—style of pump is a distinct advantage.



Edson No. 1 Pump

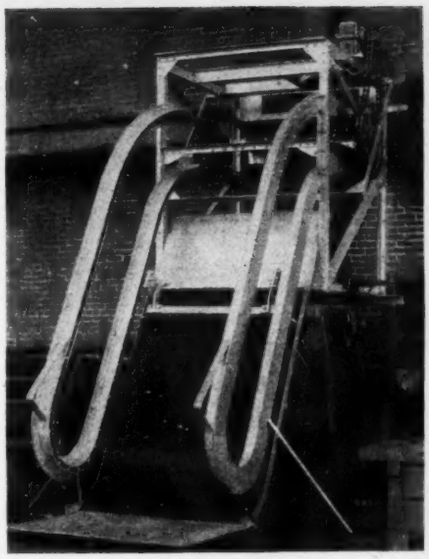
The Edson Corporation has recently established a direct stock distribution department at 142 Ashland Place, Brooklyn, N. Y., to serve the metropolitan area of New York.

If interested in such equipment the reader should write The Edson Corporation for Catalog "T" which contains full data on Edson diaphragm pumps, suction hose and pump accessories. Address the Edson Corpn., 49 D St., South Boston, Mass., or 142 Ashland Place, Brooklyn, N. Y.

▼

An Improved Self-Cleaning Bar Screen

The Jeffrey Manufacturing Company of Columbus, O., have recently announced their improved Self-Cleaning Bar Screen for the removal of coarse solids from sewage or trash from water. The screen mechanism operates automatically and has features not to be found in other screens of a similar character.



Jeffrey Bar Screen

The use of a hinged toothed scraper-rake precludes jamming of the mechanism by accumulation of solids at the bottom or on the screen bars. There are no sprockets or shafts submerged. The chain carrying the rake slides around long radius curve guide runways which drops the rake-scraper about two feet back of the screen and accumulated refuse. The arrangement of the rake is such that the teeth pass entirely through screen and there are no cross members to act as obstructions. Small objects that lodge between the bars are pulled out by the teeth and the screen has a clear opening from side to side in the submerged portion.

The control arrangement allows the cleaning mechanism to operate continuously at desired speeds of rake travel or else at intervals of from two seconds to one hour. Anti-friction bearings are employed and safety releases preclude damage from possible jamming of the rake.

The Jeffrey Manufacturing Company has just issued Bulletin No. 591 which describes this new screen—four of which are being installed at the new sewage treatment works of Lancaster, Pa., designed by J. N. Chester, Engineer, of Pittsburgh, Pa.

▼

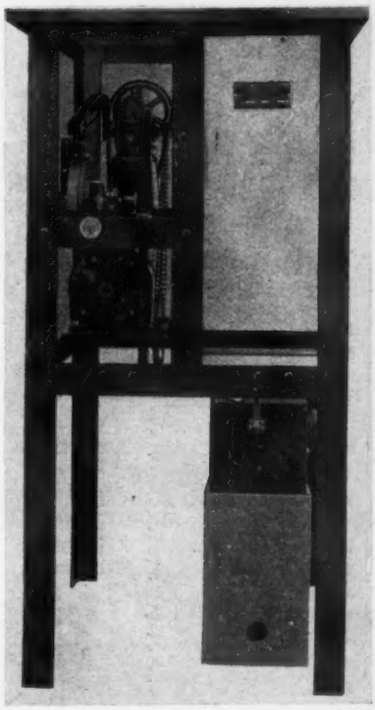
Bacharach "R. S." Dry Chemical Feeder

The new Bacharach type "R. S." dry chemical feed machine, herewith illustrated, makes use of a unique patented principle based upon an original idea that insures maximum degree of accuracy and reliability of feed.

A feed trough holds a definite amount of chemical. A displacement plunger moves from one end of this trough to the other to eject a definite and constant volume of chemical which is dissolved rapidly and discharged to the water being treated. The chemical, falling through an orifice in the bottom of the storage hopper, is received in the trough which is closed on the bottom and sides, but is open at both ends. The speed at which the plunger moves determines the rate of chemical feed.

By means of the patented principle utilized in the "R. S." feeder, it is possible to regulate the movement of the plunger so that it will require only a few seconds, or it may require many minutes to make a complete stroke. Anyone experienced in the operation of dry chemical feeders will at once appreciate this principle of design. For example, all of the chemical is forced out of the feed trough with each stroke of plunger, irrespective of whether the machine is operating at minimum, or maximum, feed. Clogging of the feed mechanism is thus avoided and thereby the most serious obstacle to feeding small rates of dry chemicals accurately and continuously is overcome.

When adjusting the rate of feed, it is merely necessary to refer to a chart supplied with the feeder and turn the regulator to a point on the indicating scale corresponding with the rate desired. The feed regulator scale and pointer are mounted in a compact assembly on the front of the machine (see illustration) at the most convenient position for visability and handling.



"R. S." Dry Chemical Feeder, Small Size

The novel design of hopper and cutting device, which has been used in all Bacharach dry feeders successfully for a period

of years, prevents arching, or clogging within the hopper, insures a continuous movement of chemical towards the outlet trough and maintains a uniform consistency of chemical in the feed mechanism. The hopper is provided with a cover to prevent escape of chemical dust and if desired the entire feeder can be mounted on weighing scales.

The "R. S." feeder, except when built for large capacity, is supplied with a 1/6 hp., 110 volt, single phase, 60 cycle electric motor. The motor is connected with standard, highest grade, reduction gears by means of grooved pulleys and V-leather belts. The entire drive unit is covered with a dustproof, removable steel housing.

Listing its advantages the manufacturer claims that the "R. S." feeder embodies every feature essential to the most exacting requirements of dry chemical feeding. The unique principle of operation makes it possible to feed at rates lower than obtainable by other means and also tends towards procuring exceedingly sensitive adjustments. The device will feed any kind of powdered, or granulated, material. Only one adjustment is required for changing rate of feed and the necessity of making check weighings of the machine discharge is avoided. For feeding powdered carbon and lime the "R. S." feeder is very effective.

For additional information address E. W. Bacharach & Company, 1200 Rialto building, Kansas City, Mo.

▼

WITH THE MANUFACTURERS

Chapman Valve Co. to Manufacture and Sell Automatic Cone Valves

The Chapman Valve Manufacturing Company of Indian Orchard, Mass., and the Automatic Cone Valve Company of Mattoon, Ill., have made an agreement whereby the Chapman Valve Manufacturing Company has been given the exclusive right and license to the manufacture and sale of all products heretofore manufactured by the Automatic Cone Company.

The entire personnel of the Automatic Cone Valve Company has been retained by the Chapman Valve Manufacturing Company. Mr. David D. Goldberg, previously General Manager of the Automatic Cone Valve Company, will have direct charge of all Cone Valve sales work and engineering design at the home offices of the Chapman Valve Manufacturing Company, Indian Orchard, Mass.

▼

Hardinge-Western Company Organized to Serve West Coast

The Hardinge Company of York, Pa.; Water Works Supply Company of San Francisco and Los Angeles; and Western Pipe and Steel Company of Los Angeles and San Francisco, have joined interests to form the new affiliated Hardinge-Western Company with head offices at 444 Market St., San Francisco. This new organization will specialize in the sanitation and water supply field in the west.

Water Works Supply Company, an old established firm with 23 years of service to its credit in the water supply and sewerage field, is a pioneer company in the west. The Western Pipe and Steel Company has also been established for several years in the pipe and culvert business. The Hardinge Company are nationally known for their line of mechanical equipment in the water purification and sewage treatment field.

Resources of these three important companies are being combined to best serve the field—with clarifiers, digesters, aerators, screens, Venturi flow meters, rapid sand filters, chlorinators, mixing devices, and other accessories.

▼

H. W. Clark Company Issues New Catalog

The H. W. Clark Company of Matoon, Ill., have just released a new and impressive catalog covering their complete line of water meter boxes, meter yokes, couplings and slip connections, designed for every climate and every condition. The catalog presents modern water meter installation practices in a manner instructive alike to operators and professional engineers. The illustrated procedure of meter removal by a "one hand operation" is particularly interesting.

Anyone interested in metering would do well to request a copy of the Clark Co. catalog No. 33 and a copy of the booklet, "The Business Basis of Metered Water"—a publication of the Water Meter Institute, which contains valuable metering information and statistics gathered throughout the U. S. A.

H. W. Clark Company, Matoon, Ill., is the only address required.

▼

McNulty Engineering Company Reorganizes and Expands

The McNulty Engineering Company of South Boston, Mass., manufacturers of the well-known automatic toggle-joint flow regulators and self-adjusting backwater gates for sewers, reservoirs and storage basins, has recently been reorganized. The new company, of which Albert P. McCulloch is president, will continue under the name of McNulty Engineering Company.

Mr. McCulloch will retain the same engineering force with Mr. John T. Magner engineer in charge, and Mr. Richard J. McNulty, who founded the business in 1910, will continue his association with the company in an advisory and consulting capacity.

The new company will continue to manufacture the same equipment with certain improvements, as did the old company, and will also specialize in the design and fabrication of special equipment for sewers and sewage treatment plants.

The offices and factory of the new company have been established at 200 Old Colony Ave., South Boston, Mass.

The History of "Cliff-Char"

In an article in the June 30th issue of *Daily Metal Trade** there appears an interesting account of the history of "Cliff-Char"—an activated carbon produced by the Cleveland-Cliffs Iron Co.

The following paragraphs have been extracted from the article referred to:

The Cleveland-Cliffs Iron Co., owner of iron ore mines on the Marquette range on Lake Superior, also owns great tracts of timber land and a plant for the conversion of the timber into charcoal which is used to smelt iron in its charcoal blast furnace at Marquette, Mich. The furnace itself is interesting as being the successor to the oldest charcoal blast furnace that was operated in the Lake Superior iron ore region. It was built in 1857.

At first, the wood from birch, beech and maple was burned in closed ovens or kilns, merely to obtain the resultant charcoal to use for furnace fuel. Charcoal had been used for iron smelting for untold ages.

The gases from the early wood distillation then went to waste. The Cleveland-Cliffs Iron Co. built equipment to reduce these waste gases to a liquor. From this "pyroligneous acid," a large body of various chemical by-products were in time developed; for example, acetate of lime, acetone, acetic acid, methanol, formaldehyde, wood tar, creosote.

While the uses for these by-product chemicals expanded, there was not enough charcoal pig iron being used to take up the charcoal resulting from the wood distillation needed to supply the required chemicals. The production of chemicals outran the output of pig iron and the chemical by-product now became the new main product. The chemical products in their new dominant position as main product, tended themselves to develop a new by-product —a surplus of wood charcoal.

To stimulate new business during the depression and to re-employ its men, the Cleveland-Cliffs Iron Co. assigned expert chemists and technicians to find new uses for its charcoal by-products. It has been successful in perfecting new methods of carbon activation which are now controlled by the company's patent rights.

Activated carbon manufactured by The Cleveland-Cliffs Iron Co., being in part a by-product, can be offered at a price low enough to commend it to the attention of all manufacturers and engineers who are faced with the problem of devising effective and less expensive means for the purification of liquids.

One of the greatest services activated carbon will perform is to render water clear and palatable. It can be used to purify water impregnated with wastes discharged from industrial plants. In fact, activated carbon has a potential usefulness that seems destined to make it the most important purifying agent known to modern engineering. Such is the history of "Cliff-Char."

*Cleveland Cliffs Iron Company Aids Recovery Program—J. F. Froggett.

"ISCO" Ferric Chloride

In the Filter Plant it is an effective and economical coagulant. **Ferric Chloride** works fast—requires less mixing and settling time.

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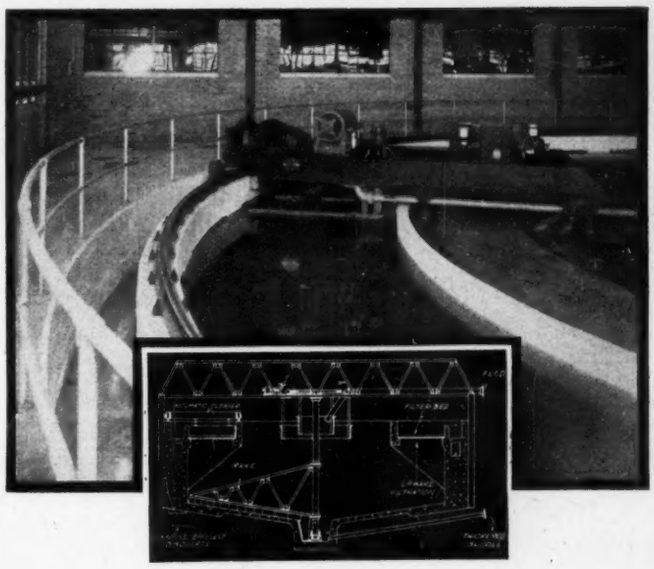

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WATER AND SEWER SUPERINTENDENT — Experienced in the operation, maintenance and construction of plants and distribution systems, available June 1. Also have had similar experience with light and power plants, but not in recent years. Have occupied present position for 12 years. Best of references. Am capable of making all tests, both chemical and bacterial, needed in the operation of plants. Location optional, but prefer towns up to 15,000 population. Address "R. W. S.," % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

BACTERIOLOGIST-CHEMIST—Age 23; B. S. and M. S. from Rutgers University. One year research experience. Want position as a chemist or operator, water or sewerage treatment works. Best of references. Location optional. Available immediately. Address "J. Z.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER—23, single, just graduated from the Massachusetts Institute of Technology with a B.S. in Sanitary Engineering; 3 years practical engineering experience; capable draftsman; formerly assistant engineer in charge of city sewer construction; desires connections with consulting engineer, municipality or State Board of Health. Address E. L. J., % Water Works & Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER—33 years of age, married, college graduate; 12 years' experience in design of sewage treatment plants, including reports and supervision, in charge of work for the last four years. Immediately available, location immaterial. Address C. B., % Water Works and Sewerage, 420 Lexington Ave., New York City.

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This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

POSITION WANTED—By practical water works man of 30 years' training. Specify in supervision of the installation and operation of coagulant and filter units; also experienced in the construction and installation of other water works equipment. Can furnish the best of references. Address J. L. K., % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

GRADUATE CIVIL ENGINEER—Age 24; experience on three different town and city sewer projects as inspector on construction. Completed two other projects as inspector on concrete pavement construction. Two years' experience as rodman, transitman, draftsman and designer of highways. Desire position preferably as engineer or inspector on a sewer project. Address "O. J. C.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER—36 years of age, married, college graduate, with M. S. degree in Chemical Engineering; experienced in water purification and Zeolite softening; two years as sanitary engineer with State Health Department. Desire position as plant superintendent or chemist in either water or sewage plant. Address "J. T. G.," % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

SANITARY ENGINEER — Graduate of North Carolina State College. B. S. in Civil Engineering—Sanitary Engineering option, desires a position as water plant or sewage disposal plant operator or any position in any phase of Sanitary Engineering; age 22; location immaterial; available immediately. Address "W. O. L., % Water Works and Sewerage, 420 Lexington Ave., New York.

GRADUATE SANITARY ENGINEER—Age 24; B. S. and M. S. from Armour Institute of Chicago, desires work in the design and construction of water softening and sewage treatment plants. Two years' experience in sanitary field. Will consider any location and salary. Address A. D. B., % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

REGISTERED PROFESSIONAL CIVIL ENGINEER AND SURVEYOR, married, desires position as city or county engineer. 25 years' experience, state, county and municipal engineering, including highways, canals, sewers, railroads and design of municipal pumping equipment. Address "H. F. R.," % Water Works & Sewerage, 420 Lexington Ave., New York City.

GRADUATE CIVIL ENGINEER—Age 27; 6 years' experience in general municipal engineering (field and office); licensed professional land surveyor; accurate estimator; location immaterial. Am very anxious to secure more experience in the sanitary field. Can furnish the best of references. Address "J. W. G.," % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

SANITARY ENGINEER—Expert on sewage, industrial wastes disposal and stream pollution, with ten years' experience and accumulated data, formely connected with largest disposal program in the U. S., also for private corporation, sales promotion and reports, qualified to investigate, study, report, design and supervise operation and construction, take charge and advise all phases of sewage disposal. Address "S. I. Z.," % Water Works and Sewerage, 400 W. Madison St., Chicago.

CHEMIST—A. B., 1923; married; 7 years director of Water and Sewage Laboratories, Indiana State Board of Health; now unemployed because of political earthquake. Want place as superintendent or chemist, water or sewage treatment works. Location or salary secondary to opportunity based on merit rather than political affiliation. Elliott H. Parks, 5715 Rawles Ave., Indianapolis, Ind.

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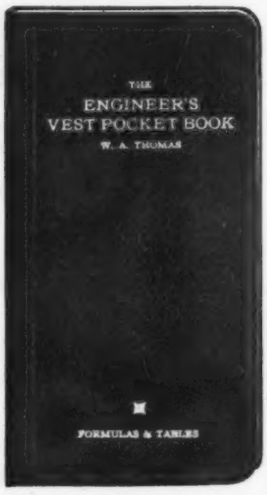

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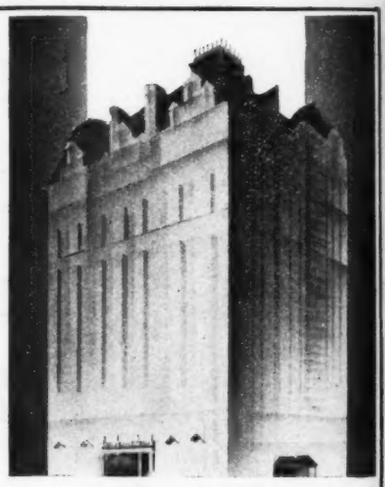

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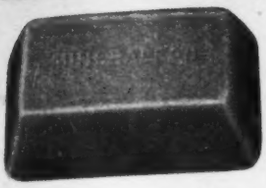

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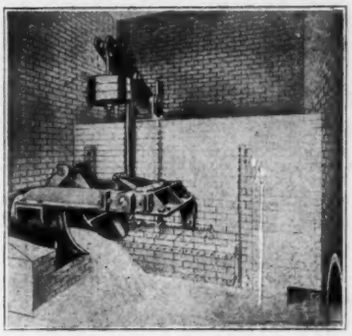

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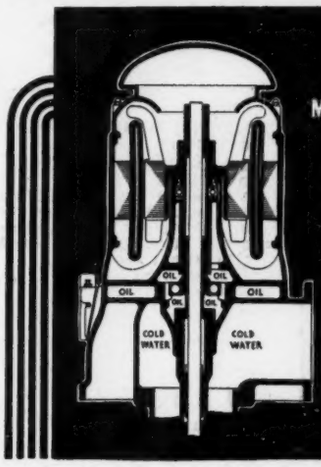

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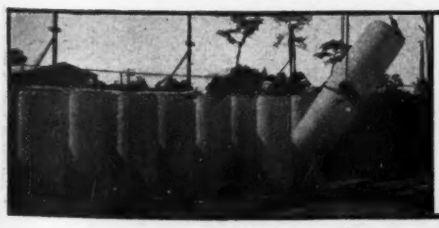

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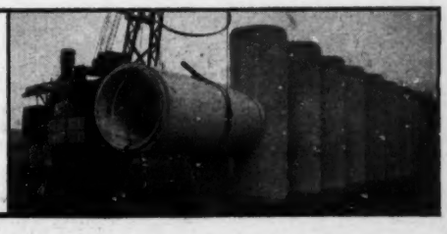

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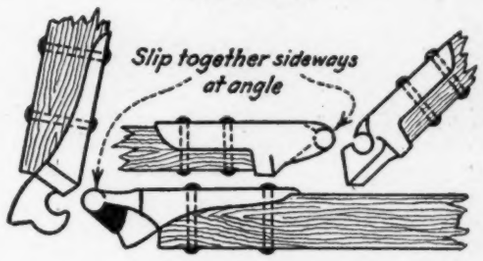

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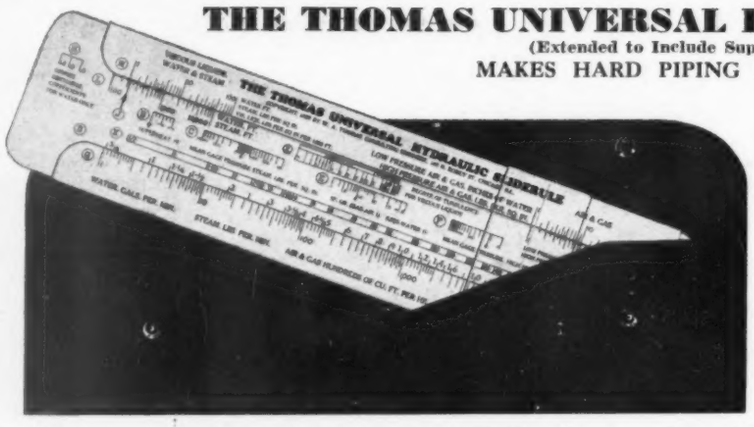

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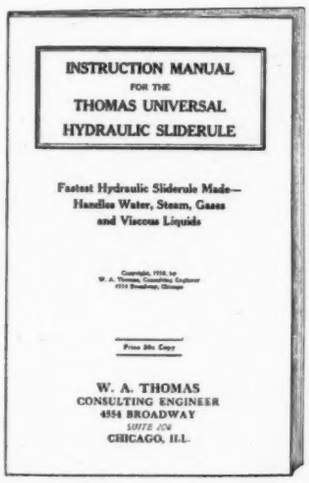

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